

HISTORIC ATTICS: HOW TO RETROFIT WITH ENERGY & INTEGRITY IN MIND

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Introduction

The needs of American homeowners have continued to evolve throughout our country's history. Due to increasing energy costs and the desire for more space, it is not unusual to have a homeowner look for ways to modify his/her house as well as ways to cut the energy costs. This desire can be especially prominent for owners of historic houses. It is possible that a house can be altered to fit the need for an extra bedroom for a growing family, an office for a hardworking parent, a studio for an aspiring artist, or a comfortable getaway to relax from life's everyday stresses. It is not uncommon for the normally under-utilized attic space to be used for these purposes.

Character is an important element of an historic house. Character can be characterized by many things, but the general definition refers to concepts of design and construction. Maintaining the character and **integrity** of a historic home should be an ongoing concern for owners of such properties. **Energy efficiency** within the home is another common issue for such home owners. **Heat flow**, in particular, is an important concern that today's homeowners must deal with. Not only are they concerned with energy costs for their home, but they are also looking for energy efficient ways to meet the previously mentioned accommodations for an ever-changing lifestyle. In fact, a 2010 survey conducted by RESNET found that 89 percent of

homeowners were concerned with how to modify their home to make it more energy efficient.¹

Some of these modifications, which will be discussed in later chapters, however, may be inappropriate and damage the **historic character** of a house. Therefore, it is important to educate owners on ways to modify an historic house to be more energy efficient, while also maintaining the house's historic nature.

This guide to retrofitting attics in historic homes focuses on historic properties located within Muncie, Indiana's historic districts. In this case, the term retrofit is used synonymously with remodeling, modification, or **alteration**. For the purposes of this thesis, the term attic is the highest potentially usable living space above the regular living spaces within a single-family, owner-occupied historic building. A historic building in this case is defined as a structure that embodies distinctive characteristics of a type, period, or method of construction, or that possesses high artistic values and resides within a historic district. According to the Smithsonian Directive 418 Appendix B: *Historic Preservation Terms*, a **historic district** is an area defined geographically or by a theme that possesses a "significant concentration, linkage or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development."² A Glossary is provided in the back of the thesis in for further reference as needed.

This guide will explore the retrofitting of attics in historic homes within Muncie's historic districts. It will also review the history of the use of the attic in order to understand the reasons

¹ Steve Baden, "New Nationwide Poll: 9 in 10 U.S. Homeowners Concerned About Home Energy Efficiency," Residential Energy Services Network, <https://www.resnet.us/blog/concerned-about-home-energy-efficiency/>

² Smithsonian Institution. "Appendix B: Historic Preservation Terms," Smithsonian Directive 418, <http://www.si.edu/Content/ahhp/pdf/SD418-AppB.pdf>

behind such changes. The anatomy of historic buildings and their attic spaces will also be addressed, as well as definitions of historic integrity and energy efficiency. Examples will be given to showcase what is being done within the historic districts of Muncie. This information by itself means little to owners of historic structures if they are not equipped with tools to correctly change the use of their attic. Therefore, a set of guidelines will be provided on retrofitting a historic attic to be energy efficient and accommodating to contemporary needs, while still being true to the historic integrity of the structure.

The thesis is divided into chapters in order to allow for the logical flow of information to homeowners. It begins with background knowledge on historic architectural styles and moves on to different alternatives for retrofitting an attic in an historic home and what codes and regulations need to be met. Chapter 1, *Attics: A Brief History*, broadly discusses the use and change of attic space over the course of American history. Different architectural styles and their modifications will be described to show how structures have evolved over time to better utilize attic space. Typical features that aided in this change will be discussed within the different architectural styles examined. The increase of attic space in some styles is a reaction to the need for contemporary, or new use, space. This chapter also gives a brief look into the practice of retrofitting attics within Muncie's historic homes, particularly in the Old West End Historic District.

Chapter 2, *Structural Anatomy of an Attic*, breaks down the arrangement of the typical attic structure and explains the reasons behind some of the framing systems that have been used. Drawings and diagrams are used to facilitate understanding of a building's structural

configuration. Other components, including **cladding** and flooring of an attic are also mentioned.

Chapter 3, *Historic Homes and Heat Flow*, looks at the main sources of heat flow within an historic home. Sketches are provided to facilitate understanding of heat flow to/from buildings.

Chapter 4, *Keeping Integrity In Mind*, discusses the levels of integrity and why it is important to maintain integrity within historic homes. Historic integrity is defined by the authenticity of a property's historic identity. Evidence of integrity is found by the survival of physical characteristics that existed during the property's period of significance. According to the National Park Service, historic integrity is composed of seven qualities: location, design, setting, materials, workmanship, feeling, and association. For the purposes of this thesis, the qualities of design, materials, workmanship, and feeling are of concern. Guidelines and regulations for historic districts are also examined.

Chapter 5, *Retrofit Alternatives for Attics in Historic Homes*, discusses the most effective ways to modify an attic for the best energy efficiency. Five alternatives to retrofitting an attic in a historic home are given, each with varying degrees of alterations and outcomes. Any adverse effects to the integrity of the structure are noted. **Insulation**, an essential feature of a livable space, will be included in the discussion— including different types of insulation typically used in a retrofit. Threats to a structure's historic fabric are also reviewed, as well as the insulation's ability to be removed.

Chapter 6, *Regulations and Incentives for Historic Home Attic Modifications*, reviews essential information that owners of historic houses should be aware of before, during, or even after an attic retrofit or remodel. This information includes energy and building codes, the Secretary of Interior's Standards and Guidelines, permit requirements, and tax incentives that help homeowners of historic residences pay for increasing energy efficiency.

This document uses a number of technical terms. Many of these terms will be printed in bold type to indicate that they can be found in the glossary at the end of the document. However, these words will only be found in bold face the first time that they appear in the thesis.

A very limited number of homes within Muncie's historic districts were available for analysis. The examples of Muncie homes are all from the Old West End Historic District. This thesis is not to be used as a building science text. Not all information discussed or retrofit alternatives will work for every house for each home is unique and should be treated as such. The content of this document is limited to the expertise of a candidate for the Master of Science in Historic Preservation through the Graduate Program in Historic Preservation at Ball State University. Therefore, it is recommended that appropriate professionals be consulted or engaged for a more comprehensive study of a structure before taking any major action.

Chapter 1: Attics, A Brief History

1.1 Changes In Use Over Time

Attics have had their share of different uses and have seen changes that reflect the socially-defined spatial needs of homeowners. The most common uses for attic space include storage or extra living quarters. These uses have remained relatively constant. However, some changes have occurred in family dynamics as well as the structural characteristics of houses, allowing for different uses to emerge.

In Massachusetts, as early as the 17th century, the attic, even in its relatively unfinished state, was often occupied. While the second story was almost always used for bed chambers, in some instances like that of the Capt. Matthew Perkins House, the eastern portion of the attic was partially finished for extra sleeping quarters and even had its own fireplace.¹ Spinning and weaving were also sometimes carried out in the attics of some Massachusetts homes.

In other early forms of housing, we can see attic space being utilized in the Shenandoah Valley in the early 18th century. German and Swiss immigrants showed their building traditions with a *Flurkuchenhaus*, or hall-kitchen house. Originally, the attics of single and two-story houses were undivided and the roof framing was left exposed. Few examples of one-and-a-half

¹ Dell Upton and John M. Vlach, *Common Places: Readings in American Vernacular Architecture*, (Athens, 1986), 224.

story houses have a finished loft or attic space.² In some Shenandoah Valley houses, the concept of multi-level attic storage can be seen in the utilization of space above roof collars, or **tie beams**.³ Figure 1.1 shows what this type of storage might resemble. During the beginning of the 19th century, this type of house was abandoned for the I-house form. This change caused a shift in room function. Storage and farm-related activities that had been housed in the attic and cellar were later provided for in detached buildings.⁴

In 18th century Virginia, one-and-a-half-story houses usually had a full-height ground floor and a loft, or attic space, that was regularly used and sometimes finished. In later years, these spaces were lit by daylight through the use of **dormers**.⁵ The daylight coming through the dormer windows allowed the space to be used for more than just sleeping because there was now ample light to carry out activities.

Also in the 18th century, from about 1710 to the American Revolution, log homes were a popular choice of house type. The floor of the attic story, or loft, which could be accessed by a ladder in a corner of the cabin, was generally used for grain storage and a sleeping space for the children.⁶ The roof **pitch** was low, allowing a person to stand erect only in the middle, while children moved about the space easily.

² Dell Upton and John M. Vlach, *Common Places: Readings in American Vernacular Architecture*, (Athens, GA, 1986), 31.

³ *Ibid.*, 34.

⁴ *Ibid.*, 42.

⁵ *Ibid.*, 332.

⁶ Rexford Newcomb, *Architecture of the Old Northwest Territory: A Study of Early Architecture in Ohio, Indiana, Illinois, Michigan, Wisconsin, & Part of Minnesota*, (Chicago, 1950), 49.

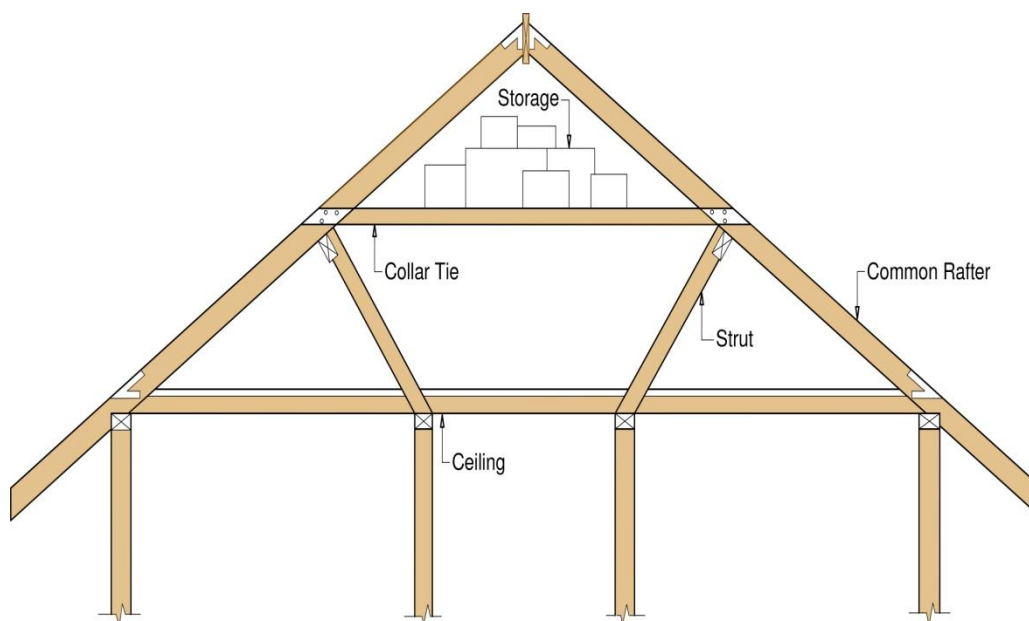


Figure 1.1 Storage Above Attic Tie Beam.⁷

1.2 Architectural Styles

Although not all architectural styles that will be discussed are typical of Muncie, it is important to examine them in order to understand how homes and their attics have changed over time. Different architectural styles have been created and modified over the years to better utilize space in the upper levels of a home. Several of these architectural types borrow features from other styles in order to create a space that is usable and more suited for the changing needs of a homeowner. Builders were beginning to mold and shape houses into better-utilized structures with stylistic alterations as far back as the 17th century. Typical features that aided in this change include jetties (discussed below) and dormers, as well as **mansard** and **gambrel** roofs.

⁷ Susan Leigh Smith, *Storage above attic tie beam*, 2015, Muncie

1.2.1 New England Colonial 1600-1700

During the early settlement of the United States, the New England territory had several distinctive house types including Cape Cod, Salt Box, Rhode Island Stone-ender, Garrison, New England Large, and New England 1½. These styles of houses are box-like and typically expand by extending the rear roof **slope** to add rooms. Other useable space was made by placing windows in the **gable** end, forming a half story structure and allowing for use of the attic space with the additional light. In larger houses, such as in the Garrison House-type (Figure 1.2), the upper floor projected beyond the lower floors creating an overhang, known as a **jetty**.⁸ The Garrison House-type stems from medieval house design in Europe that had an environmental and economic reason for the jetty. Not only did it provide protection against weather, it also maximized the floor area allowing for more living space on small lots.⁹ The Garrison House style is not typical of Muncie, Indiana's historic districts. However, there are some instances, like the house in the Old West End Historic District pictured below, that have the same massing and extending jetty on the second story.

⁸ John J.G. Blumenson, *Identifying American Architecture: A Pictorial Guide to Styles and Terms, 1600-1945*, (New York, NY, 1981), 11.

⁹ Allen G. Noble, *Wood, Brick, & Stone: The North American Settlement Landscape*, (Amherst, 1984), 22.



Figure 1.2 Jetty Characteristic of The Garrison House Style. South Gharkey Street, Muncie, IN.

1.2.2 Grenier House 1700s

This 18th century house type originated in the early French settlements of the United States within the **Mississippi Delta cultural hearth**. A cultural hearth is an original source area with distinctive settlement forms as well as other cultural attributes including building traditions.¹⁰ In the Mississippi Delta region, the cultural attributes had French and Cajun influences. Also known as the Acadian House or Creole House, the Grenier House (Figure 1.3) gets its name from the French designation of its oversized loft, or attic. Originally the attic space was used as sleeping quarters for the bachelor men of the family, but later functioned to store grains, pelts, and animal traps.¹¹

¹⁰ Allen G. Noble, *Wood, Brick, & Stone: The North American Settlement Landscape*, (Amherst, 1984), 7, 88.

¹¹ *Ibid*, 89.



Figure 1.3 Grenier House Style. Ste. Genevieve, MO.¹²

1.2.3 French Colonial 1700-1830

French Colonial style houses (Figure 1.4) are distinguishable by their dual-pitched **hipped roofs** that in the original forms were thatch covered. In most cases the overhanging **eaves** of the roof encompassed a **gallery** that surrounded the house. Tall and narrow gabled dormers were sometimes used to provide attic lighting.¹³ Sometimes the roof is propped up off the structure's walls allowing for air movement. During the summer, a family could use this space to store and dry grain. Again, this style is not typical of Muncie's historic districts.

¹² Grenier House Photo. Ste. Genevieve, MO. May 26, 2007.
http://commons.wikimedia.org/wiki/File:Photograph_of_a_house_on_Gabouri_St_in_Ste_Genevieve_MO.jpg.
 Andrew Balet.

¹³ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 122.



Figure 1.4 French Colonial Style House. Bolduc House in Ste. Genevieve, MO.¹⁴

1.2.4 Dutch Colonial 1700-1830 and Colonial Revival 1870-1920

The early Dutch Colonial style houses were typically one story with steeply pitched side gabled roofs with little or no eave overhang. In the earliest period, the uppermost area was used for grain storage and was later **partitioned** to create small bedrooms.¹⁵ After about 1750, however, gambrel roofs became common. This type of roof form was used as a means of increasing both roof span and useful attic space.¹⁶ Later in the 19th and 20th centuries, this style was revisited in what is known as Colonial Revival (Figure 1.5) that became a popular architectural style. According to the McAlesters, 10 percent of these houses are in the Dutch Colonial subtype and have gambrel roofs. Most of these types of houses are the traditional one story, but the steeply pitched gambrel roof contains an attic space that is almost a full second

¹⁴ French Colonial Residence Photo. Bolduc House in Ste. Genevieve, MO. 2010. Facing East. Stephanie Schwartz

¹⁵ Allen G. Noble, *Wood, Brick, & Stone: The North American Settlement Landscape*, (Amherst, 1984), 29.

¹⁶ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 116.

story. Other features of this type that increased the headroom in the attic include separate dormer windows or a large shed dormer.¹⁷ This style can be seen occasionally in some of Muncie's historic districts. Figure 1.5 shows a more **vernacular** version of the style.



Figure 1.5 Dutch Colonial Revival Style House. South Mound Street, Muncie, IN.

1.2.5 Georgian 1700-1800

These simple, symmetrical houses may not seem as though they would contain large attic spaces, but the moderate to steeply pitched roofs usually contain dormers or gable-end windows that allow ample lighting and a decent amount of space (Figure 1.6). According to the McAlesters, about 25 percent of the surviving Georgian style houses are of the Gambrel Roof

¹⁷ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 322.

subtype. These houses have gambrel roofs, mentioned above, which is an adaptation of the gable form. This provides more headroom in the attic space for storage or sleeping.¹⁸



Figure 1.6 Georgian Style House.¹⁹

1.2.6 Gothic Revival 1830-1860

Verticality is an important feature in Gothic Revival houses. This can be seen in the style's use of steeply pitched roofs and **wall dormers** (Figure 1.7).²⁰ Due to these characteristics, it would be plausible to assume that the attic spaces in these homes were used frequently. The wall dormers would not only allow light into the upper story, but would also

¹⁸ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 139.

¹⁹ Georgian Residence Photo. <http://www.activerain.com>. (Accessed March 5, 2013)

²⁰ John J.-G. Blumenson, *Identifying American Architecture: A Pictorial Guide to Styles and Terms, 1600-1945*, (New York, NY, 1981), 31.

expand the usable space since such steeply pitched roofs do not allow for a great deal of headroom.



*Figure 1.7 Gothic Revival Style House.*²¹

1.2.7 French Second Empire 1860-1890

This style (Figure 1.8) is characterized by its distinctive roof, known as a Mansard roof (named after French architect Francois Mansart).²² This type of roofline has two pitches and can either be convex or concave. The boxy roof line was considered particularly functional because it permitted a full upper story of usable attic space. Frequent dormer placement within the style also contributed to making the attic story usable by providing ample light. For these reasons, the style became rather popular.

²¹ Gothic Revival Residence Photo. <http://www.oldhousedreams.com>. (Accessed March 5, 2013)

²² Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 242.



*Figure 1.8 French Second Empire Style House.*²³

1.2.8 Queen Anne 1880-1900

The irregularly-shaped Queen Anne house type of the Victorian Era has the most stylistic freedom (Figure 1.9). Typically, a house in this style is two full stories and is capped by a large third-story attic. The roof is steeply pitched and may either be gabled or hipped.²⁴ Characteristics of this style include dormers and several prominent and projecting gables, sometimes cantilevered out beyond the plane of the walls below. **Bay windows** are also common, which also provide for more usable space. This house type is common within Muncie's historic districts. Other Victorian Era houses like Stick, Richardsonian Romanesque, and Shingle have similar characteristics that make the attic space more functional.

²³ French Second Empire Residence Photo. July 10, 2009. <http://historicbuildingsct.com>. (Accessed March 5, 2013)

²⁴ Allen G. Noble, *Wood, Brick, & Stone: The North American Settlement Landscape*, (Amherst, 1984), 145.



Figure 1.9 Queen Anne Style House. West Adams Street, Muncie, IN.

1.2.9 Tudor 1890-1940

This eclectic style is typically one story with a large steeply pitched roof, often with prominent **cross gables** (Figure 1.10). A dominant, front facing gable is common. Sometimes these gables are **parapeted** or have a slight overhang. Overlapping gables with eave lines of varying heights are common.²⁵ With these features, this style makes for a large attic space with ample headroom.

²⁵ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 356.



*Figure 1.10 Tudor Style House.*²⁶

1.2.10 Craftsman and Bungalow 1905-1930

Craftsman style houses are usually front-, side-, or cross-gabled with exposed roof **rafters** and decorative beams.²⁷ The Bungalow style is a simple form that usually is only one story (Figure 1.11). Depending on the roof pitch and additional features like dormers, attic space in this type of house varies. In some cases, the roof has a low pitch with minimal windows or dormers. This would allow the space to be used for storage, but not necessarily as livable space. Other houses of this type that have large gable fronts or large dormers can allow the attic space to be utilized as part of the living quarters of the house.²⁸ If the roof pitch is higher and has a large dormer, this configuration adds headroom making the space quite usable.

²⁶ Tudor Residence Photo. <http://www.ontarioarchitecture.com>. (Accessed March 5, 2013)

²⁷ Virginia McAlester & Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 453.

²⁸ Allen G. Noble, *Wood, Brick, & Stone: The North American Settlement Landscape*, (Amherst, 1984), 148.



Figure 1.11 Craftsman Bungalow Style House. West Orchard Street, Muncie, IN.

Families have been using their attics to suit their needs for centuries and architecture has evolved to accommodate these needs. In recent years, it has become increasingly popular to make the attic a more integral part of the home, as opposed to the limited earlier functions of storage or sleeping. Today, homeowners have begun to modify the attic space in order to accommodate other uses including bedrooms, storage, studios, game rooms, offices, etc.

1.3 Attics in Muncie’s Historic Districts

Muncie boasts ten National Register historic districts, each having its own distinct characteristics. Figure 1.12 displays the locations of the historic districts and their names. With the exception of Beach Grove Cemetery, these districts are filled with historic homes that would be great candidates for usable attic space. After conducting a survey of The Old West

End historic district, it was observed that most of the building stock in that particular neighborhood would have an attic space capable of being used for some functional purpose. Judging by the exteriors and massing of the homes, it appears that some may have headroom in the attic space, but others may not have adequate height. However, it could still be possible to modify the space to be usable. Several structures in other historic districts also have the potential to use attics for less historically conventional purposes as well.

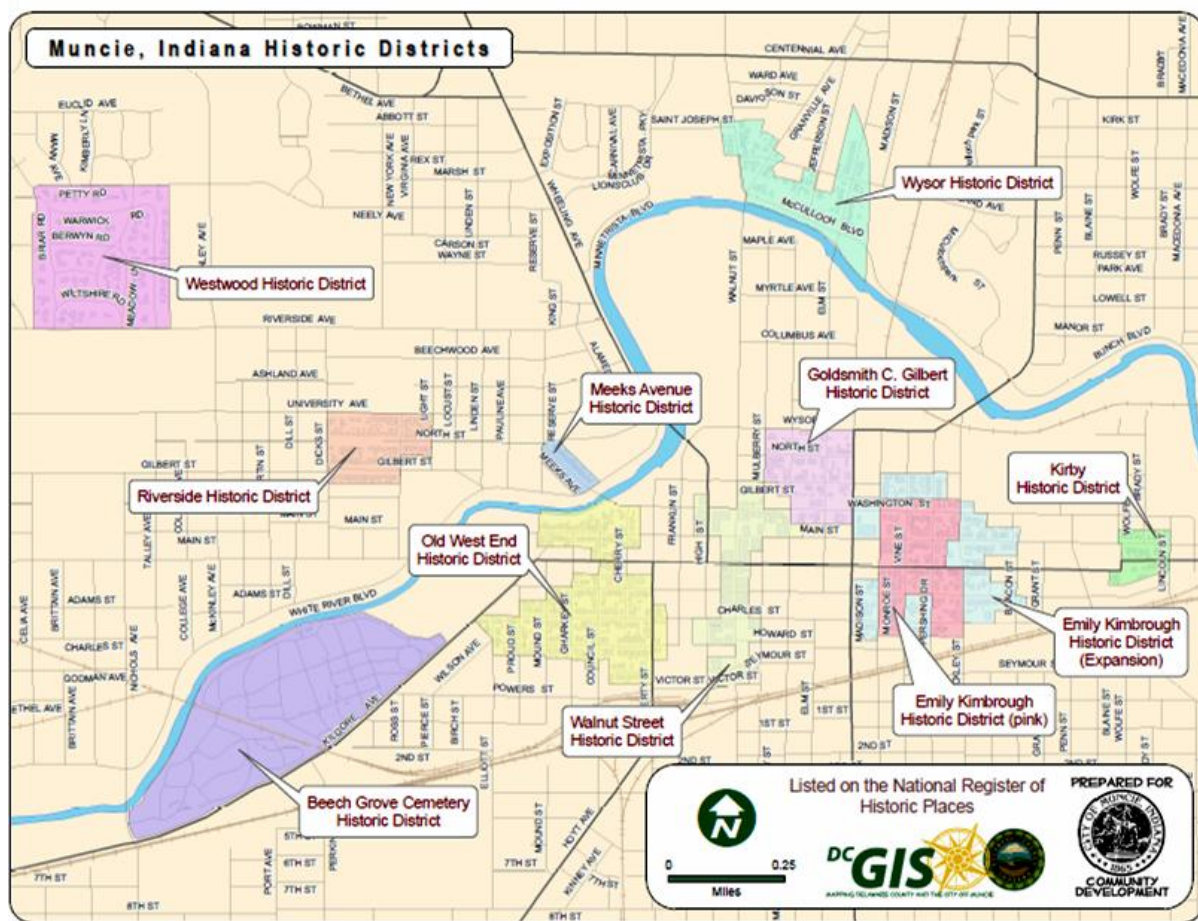


Figure 1.12 Muncie, Indiana Historic Districts.²⁹

²⁹ Muncie, Indiana Historic Districts Map.

<http://157.91.22.196/dcgis/communitydevelopment/DocsMaps/Historic%20District%20Overview%20Map%208x11.pdf>. (Accessed March 5, 2013)

In order to get a better feel for the types of houses that would have usable or non-usable attics within the neighborhoods, the following two examples show the differences that can be found within Muncie's Historic Districts. The house in Figure 1.13 for example, has a steeply pitched roof, various windows, and a dormer; it is possible for this Queen Anne style house to have a usable attic space. Figure 1.14 shows the opposite. There does not seem to be any type of headroom in this example due to its shallow pitched roof and it has no dormers or windows that would make someone suspect otherwise.



Figure 1.13 House With Potential For Usable Attic Space. West Charles Street, Muncie, IN.



Figure 1.14 Houses Without Potential For Usable Attic Space. West First Street, Muncie, IN.

After touring a few homes in the Old West End Neighborhood and talking with the owners, some of them spoke of their desires to retrofit their attics into spaces they could utilize. One reason for this is the need for contemporary space to grow with the family. One family with a circa 1901 vernacular Queen Anne style house is currently not using the attic space at all. Attic windows give the indication that a more beneficial use would be plausible. This particular family had several ideas for what they would like to do with the space—including an extra bedroom, an artist studio, or a playroom for their child. Figures 1.15 and 1.16 show an exterior view of the house as well as a view of the interior attic space.



Figure 1.15 1901 Queen Anne Residence. South Mound Street, Muncie, IN.



Figure 1.16 Queen Anne Residence Attic Space.

Another Old West End resident living in a 1900 Dutch Colonial house has been using the upper story as an office space, with the side attics being used for storage. In order to increase energy efficiency, the owners have stapled insulation to the walls of the attic. Figures 1.17-1.19 show an exterior view of the house and interior shots of the different attic spaces within the structure.



Figure 1.17 1900 Dutch Colonial Residence. West Charles Street, Muncie, IN.



Figure 1.18 Dutch Colonial Residence Office Attic Space.

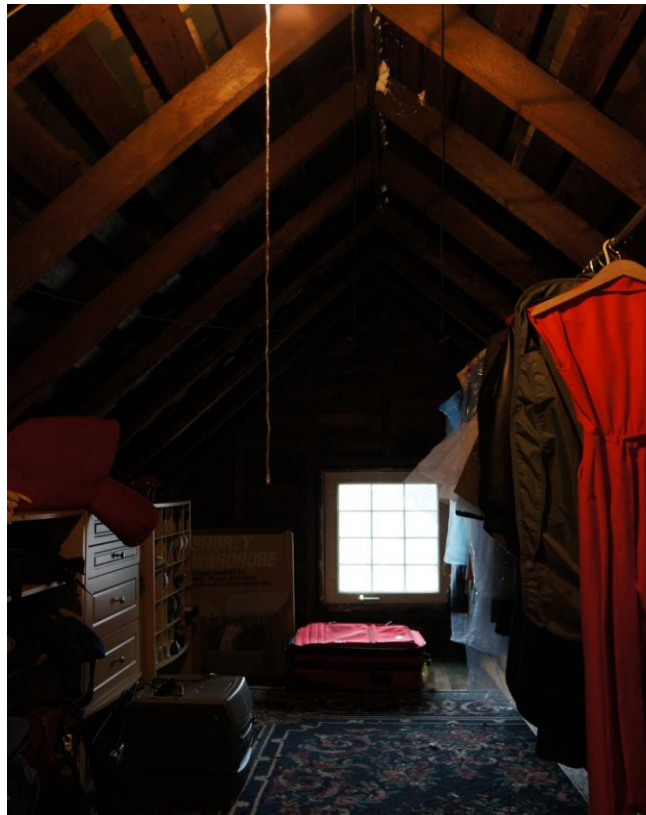


Figure 1.19 Dutch Colonial Residence Side Attic Used For Storage.

Due to the interest in retrofitting attic space for contemporary use, media such as television and the internet have been demonstrating new ideas for attic uses. Previously, the only way to know how a family used their attic space was by their diary or the furniture that was left behind, but today people can watch television shows on home improvement networks like HGTV and even on social media sites such as Pinterest (Figure 1.20). This new trend, combined with the desire for energy efficiency, is beginning to shape the way people look at their attic spaces.

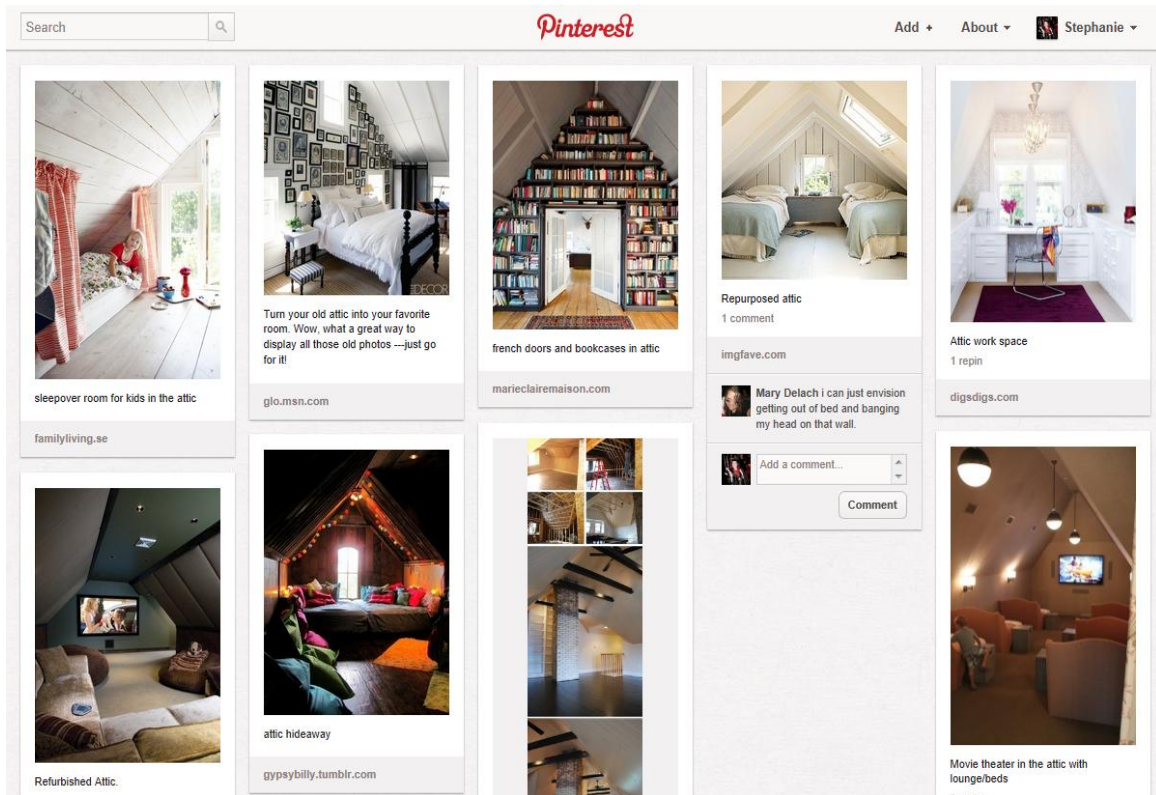


Figure 1.20 Attic Uses Shown On Pinterest.³⁰

³⁰ Attic Uses On Pinterest. "Attics for Thesis." Pinterest. <http://pinterest.com/smschwartz11/attics-for-thesis>

Chapter 2: Structural Anatomy of an Attic

It is essential to understand how a house and its attic space are constructed before altering an attic in any way. Because many of the residences in Muncie's Historic Districts were built in the early 19th to the mid 20th century, it is important to look into the types of building construction and roof framing that were being used in such houses. If a homeowner has not already done so with their own home, this chapter may assist in figuring out what type of framing that is used in a particular house.

2.1 Building Construction

In the 19th century, lumber became established as the premier American building material. Wooden walls and roofs are composite, meaning that they are made up of small units that are linked together to make a whole. The wood was commercially cut into standardized lengths, widths, and thicknesses using various emerging technologies such as the circular and pit saw, steam- and water-powered cutting devices, and then assembled using wire or **cut nails**. Three of the most widely used methods of this “stick” framing construction were braced, balloon, and platform.

2.1.1.1 Braced Framing

This framing system (Figure 2.1), a modification of post and beam framing, replicated hewn timbers by nailing lumber pieces together to form structural members as thick as timbers.¹ Because this method still used heavy corner posts and horizontal timbers, but employed thin **studs**, it essentially combined the heavy structural system of the post and beam method of timber framing, with lighter framing techniques. Thus began the creation of the stick framing method.²

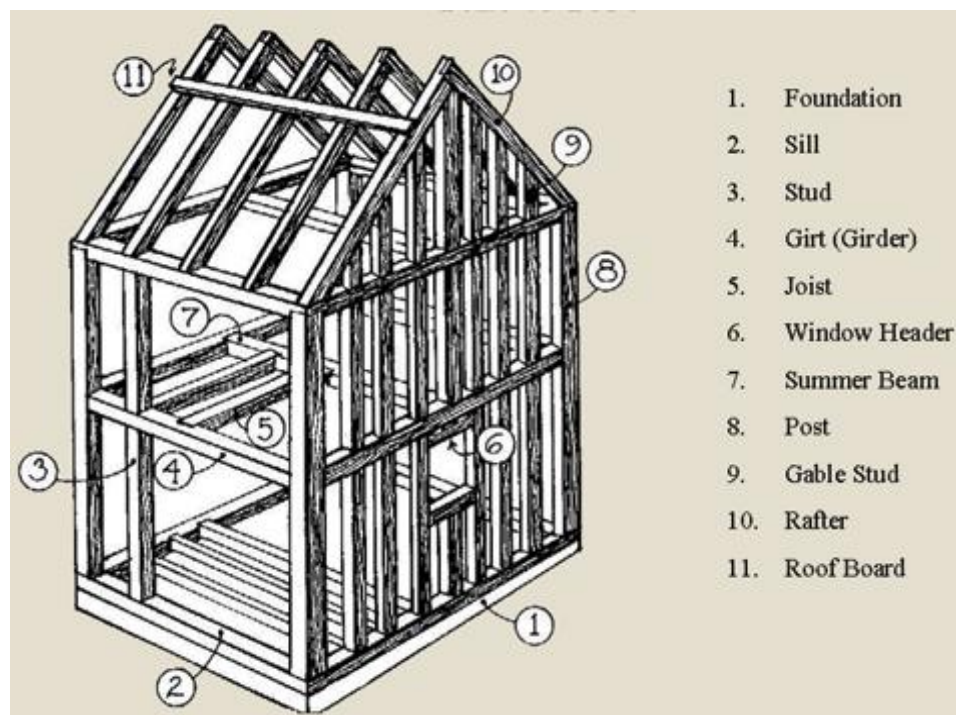


Figure 2.1 Diagram of the Braced Framing System.³

¹ Allen G. Noble, *Wood, Brick, and Stone: The North American Settlement Landscape*, (Amherst, 1984), 137.

² Robert A. Young, *Historic Preservation Technology*, (Hoboken, 2008), 59.

³Diagram of the Braced Framing System. Randy Howland, "Framing," *Inquiring Eye Home Inspections, LLC*, <http://www.inquiring-eye.com/anatomy/framing.htm>.

2.1.2 Balloon Framing

Balloon framing (Figure 2.2), the most popular of the stick framing methods, was invented in Chicago in 1833, but did not become important in residential construction until about 1850.⁴ This form of construction got its name because of its supposed lack of solidity due to the fact that it was composed of light members joined only by wire nails. It used lumber sawn to standard sizes in moderately small two-by-four “sticks,” known as studs, which were typically spaced uniformly at sixteen inches, to form a wall system that was light yet strong and rigid.⁵ The wall studs and posts extend in one piece from the foundation all the way to the roof. With the studs and posts extending uninterrupted, a continuous vertical **cavity** that ran from the basement to the attic space was created, causing a chimney-like effect in the case of fire.⁶ In early forms, the system would sometimes fail due to lack of diagonal strength. To combat this, later forms added diagonal bracing as well as laying the subflooring diagonally across the **floor joists**. This style of construction allowed house plans to break away from the traditional rigid box form and facilitated an array of house types and architectural styles. The Queen Anne was the most abundant style to be created out of this type of construction and made full use of the method’s lack of restrictions by using elaborate detailing and complex shapes.⁷

⁴ Dell Upton and John M. Vlach, eds., *Common Places: Readings in American Vernacular Architecture*, (London, 1986), 161.

⁵ Barbara J. Howe, Dolores A. Fleming, Emory L. Kemp, and Ruth A. Overbeck, *Houses and Homes: Exploring Their History*, (Lanham, 1997), 112.

⁶ Robert A. Young, *Historic Preservation Technology*, (Hoboken, 2008), 56.

⁷ Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 264.

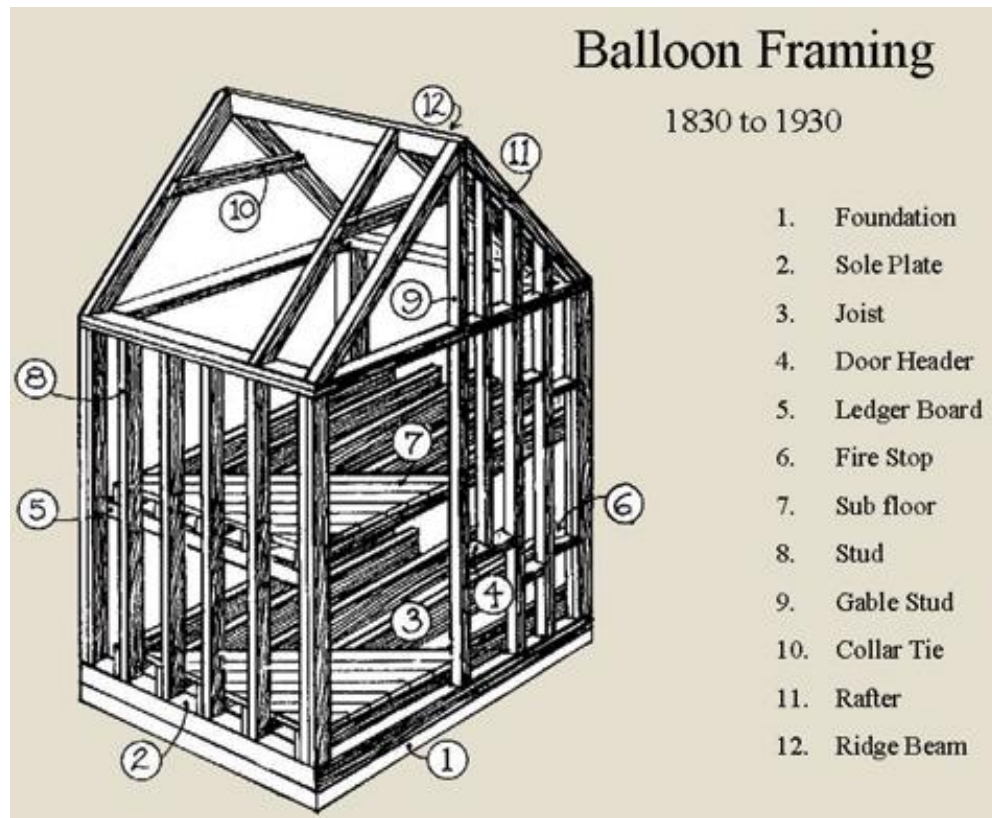


Figure 2.2 Diagram of the Balloon Framing System.⁸

2.1.3 Platform Framing

Platform framing (Figure 2.3) emerged about seventy years after balloon framing became popular. Also known as Western frame, this type of construction is used when each story or floor of a building is erected as a separate unit. Each wall is also built as its own entity. After each wall is assembled, the floors are erected one at a time and hoisted onto a platform which has already been put in place.⁹ This process could be repeated several times to reach the desired height. At the peak of its popularity, it became the method of choice for segment construction, houses assembled in sections, and such homes were sold as house “kits” through

⁸ Balloon Framing Diagram. Randy Howland, “Framing,” *Inquiring Eye Home Inspections, LLC*, <http://www.inquiring-eye.com/anatomy/framing.htm>

⁹ Allen G. Noble, *Wood, Brick, and Stone: The North American Settlement Landscape*, (Amherst, 1984), 137.

catalogs and magazines.¹⁰ This type of construction is usually safer to build than balloon framing, because the numerous parts are not assembled many feet above the ground as in balloon framing construction. Sections can also be worked on simultaneously, allowing for better efficiency in aspects like construction time and labor hours.

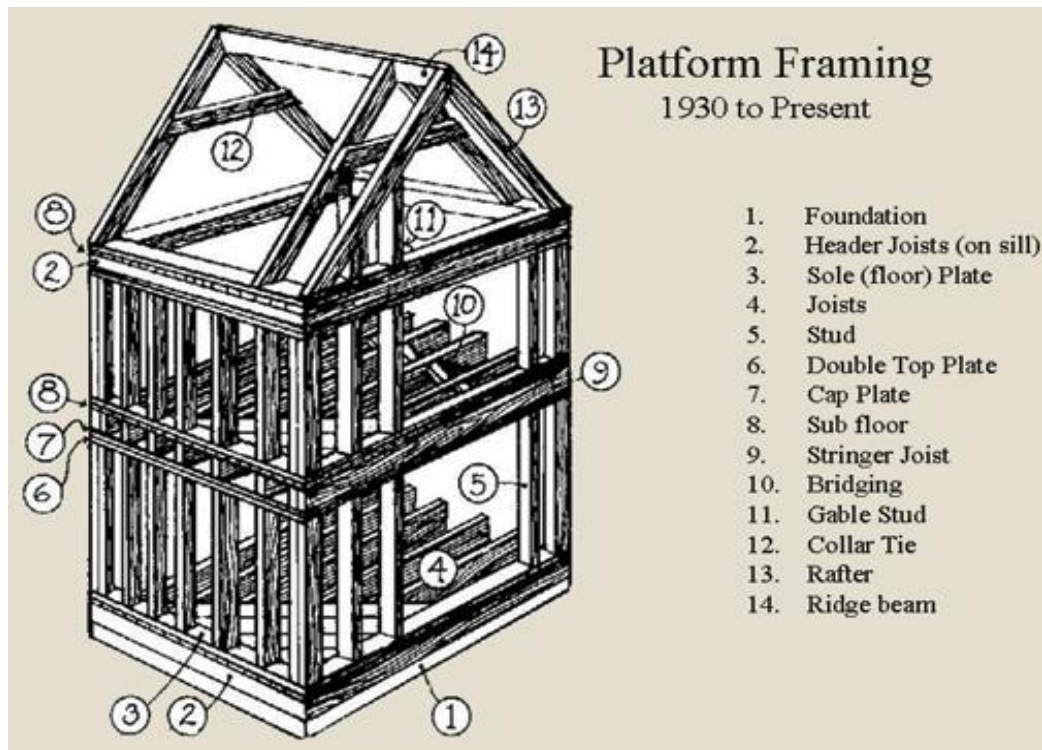


Figure 2.3 Diagram of the Platform Framing System.¹¹

2.2 Roof Framing

Houses are a combination of four basic components including foundations, walls, roofs, and architectural details. Roofs have three fundamental shapes (gable, hipped, and flat) and each has several different subtypes. The roof is one of the most dominant features of a building

¹⁰ Robert A. Young, *Historic Preservation Technology*, (Hoboken, 2008), 56.

¹¹ Platform Framing Diagram. Randy Howland, "Framing," *Inquiring Eye Home Inspections, LLC*, <http://www.inquiring-eye.com/anatomy/framing.htm>

and helps determine the architectural style as well as what kind of attic space it will have.

Typically, roofs are supported by a wooden framework. This is because wood is relatively light weight, yet strong, and can provide adequate support for the building's load and span.¹²

There are two principal roof framing systems that are used in American houses. Both methods use a series of rafters, or single inclining boards, and **trusses**, a group of rafters assembled in triangles acting as a unit, to make up a support system. The first uses heavy main rafters, known as principal rafters, that require little additional bracing to support the remainder of the roof (Figure 2.4). The other, used with stick framing such as braced, balloon, and platform, uses lighter weight rafters, known as common rafters, at a lower pitch or longer span (Figure 2.5). Both roof framing systems need additional underlying supporting systems of joists and trusses. **Gable roofs** involve the least complex supporting framing, while shapes like gambrel or hipped roofs will need further framing members.¹³ Roof shapes can vary depending on the architectural style of the house, climate, and cultural building traditions. Therefore, the framing system and its supports will be determined by those factors. If a style offers a steep roof, then the principal rafter method would most likely be used. If the roof is lower in pitch, the common rafter method would be employed. Figure 2.6 shows the different framing supports, or trusses, that might appear in various historic houses.

Some roof slopes are interrupted by dormers (Figure 2.7), usually having the same shape as the rest of the roof. These are meant to provide space, light, and ventilation to an attic and are therefore an integral part of the attic structure. They can be considered an architectural detail of the structure.

¹² Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 42.

¹³ Ibid., 44.

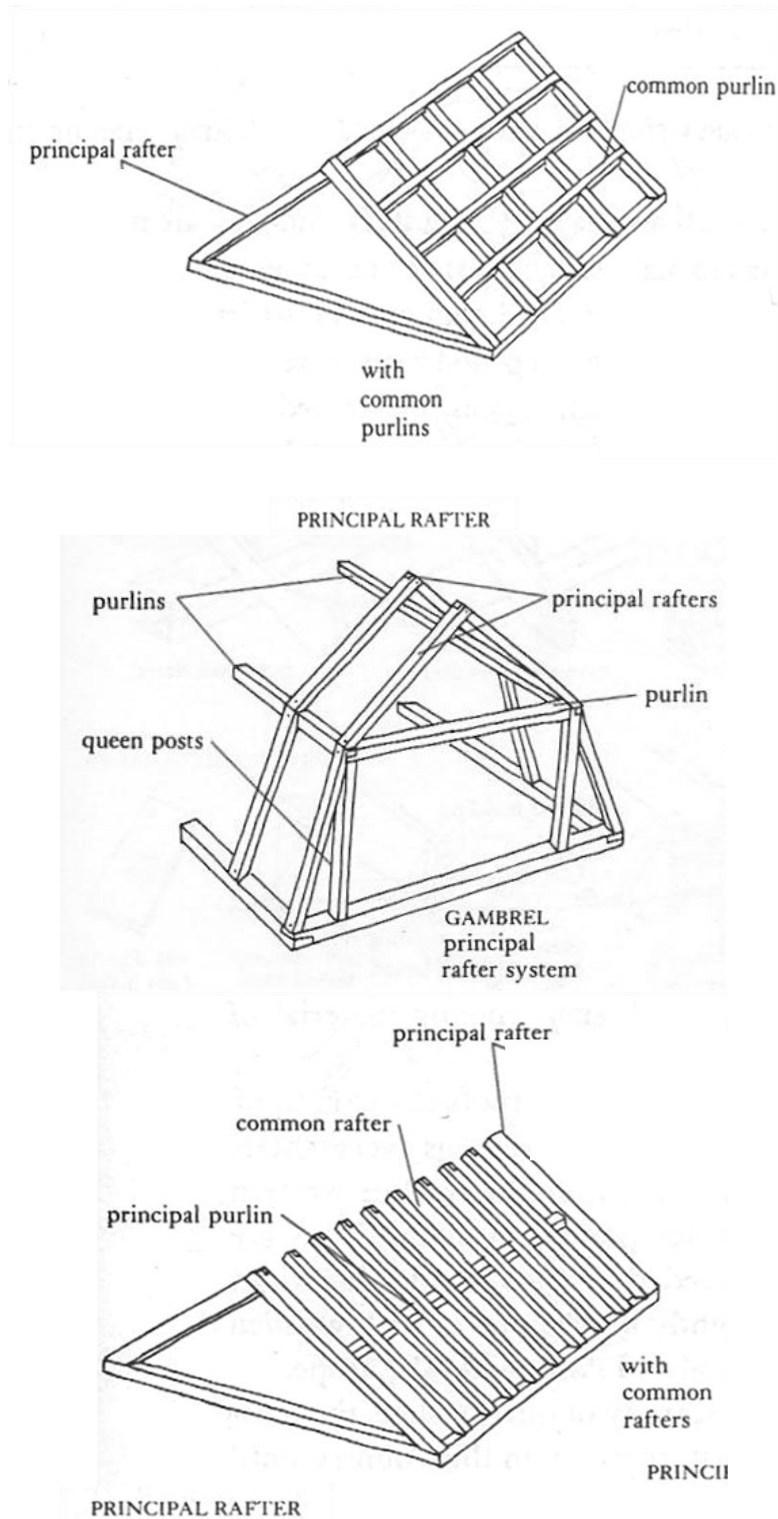


Figure 2.4 Principal Rafter Roof Systems.¹⁴

¹⁴ Rafter Trussing Systems Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 44.

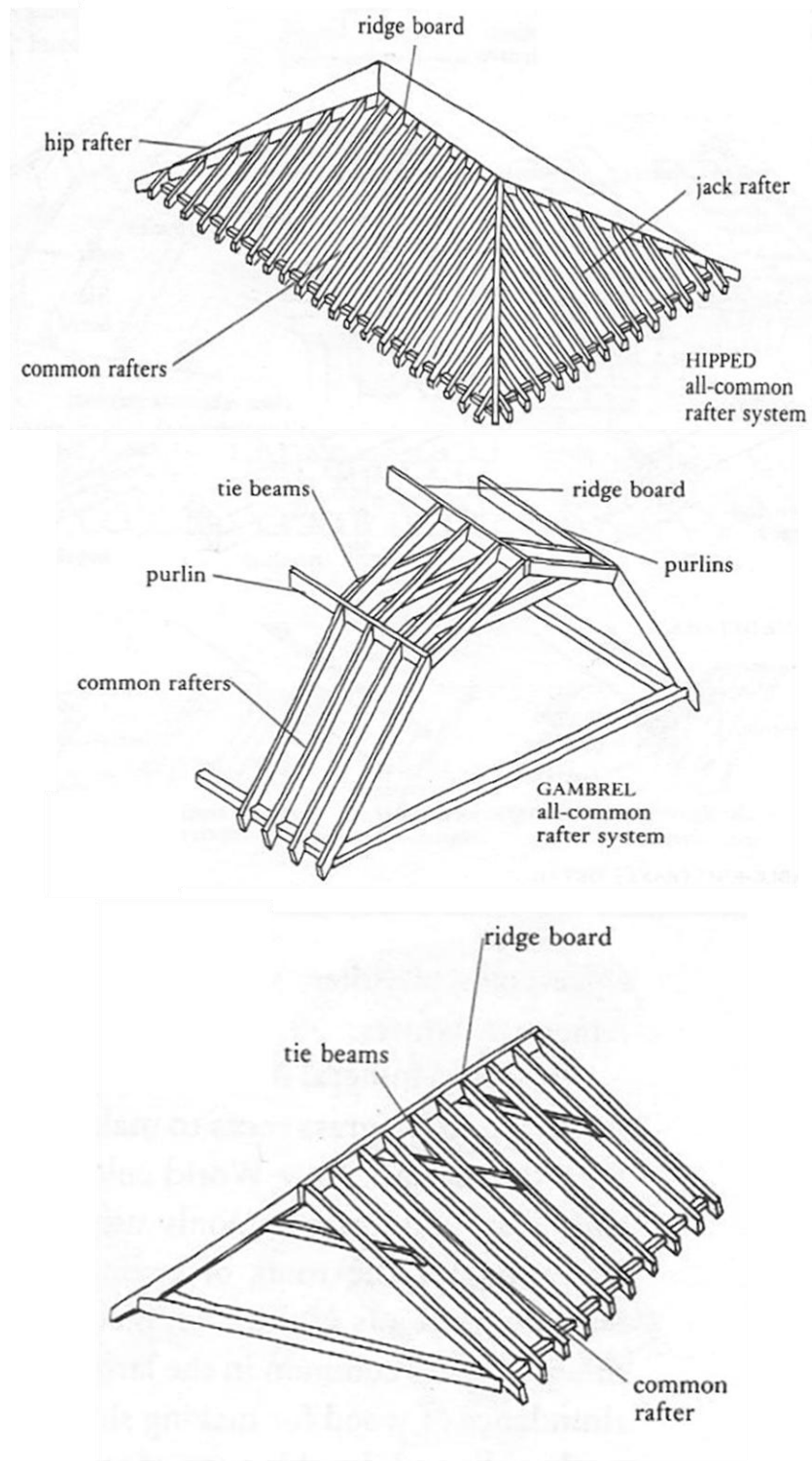


Figure 2.5 Common Rafter Roof Systems.¹⁵

¹⁵ Typical Gambrel Roof Framing Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 44.

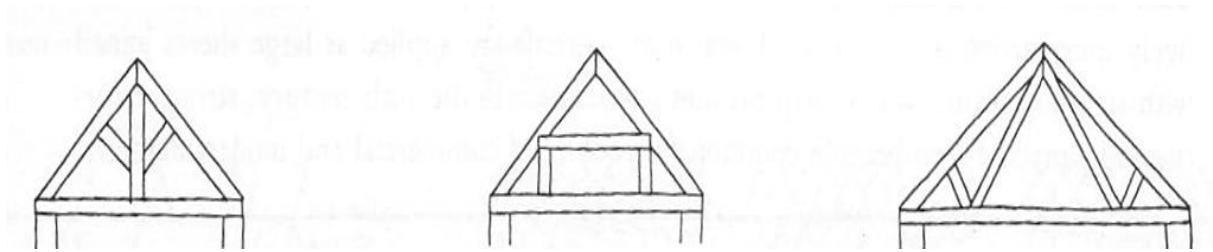


Figure 2.6 Typical Roof Truss Systems.¹⁶



Figure 2.7 Examples of Dormers. West Orchard Street, Muncie, IN.

2.3 Other Roof and Attic Technologies

Although this thesis will not discuss all roofing materials, it is important to note the typical cladding systems that are most associated with attics in historic homes. The roof and its materials are critical to the long-term integrity of a building because they provide the first line of defense against water infiltration into the house below.¹⁷ They also protect against other elements such as sun, wind, and snow. This cladding has four principal material types. The first is organic coverings including thatch, boards, and wood **shingles**. The second type is mineral materials that include earth, slate, stone, and ceramic tiles. Metal roofs could consist of sheets, corrugated panels, or metal shingles

¹⁶ Rafter Systems Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 44.

¹⁷ Norman Tyler, Ted J. Ligibel, and Ilene R. Tyler, *Historic Preservation: An Introduction to Its History, Principles, and Practice*, 2nd ed., (New York, 2009), 221.

and tiles. The last material type is **bitumen** which could use tar for flat roofs, composition sheets for roll-on roofing, or composite shingles.¹⁸

Typically, above the rafters and roof decking, there will be a **felt underlayment** that rests underneath the roofing material. The roof decking, or sheathing, is applied to the roof rafters. The felt underlayment is attached to this layer to provide an extra (secondary) water barrier and protection for the attic and structure below. Roofing materials of historic homes vary from clay tile and slate to wooden shingles; however, there are also instances in which owners of historic homes have replaced these materials with modern **asphalt** based shingles.¹⁹ Figure 2.8 shows an example of typical modern roof cladding. Older homes usually have some form of roof vent or **soffit vent** to allow for ventilation of **unconditioned** attic spaces.



Figure 2.8 Roof Cladding.²⁰

¹⁸ Virginia McAlester and Lee McAlester, *A Field Guide to American Houses*, (New York, 2009), 47.

¹⁹ Randy Howland, "Roofing," Inquiring Eye Home Inspections, LLC, <http://www.inquiring-eye.com/anatomy/roof.htm>

²⁰ Roof Cladding. "Roofing 101: Roof Anatomy," SOS roofing, <http://www.sosroofinginc.com/roofing101.html>

Attic flooring is another issue that should be briefly addressed. Some attics in historic homes will not have any flooring, leaving the **ceiling joists** of the room below exposed. Other historic houses, where the attic was traditionally used for storage, may have a floor already constructed. If the attic has no floor and there is a desire to use the space for storage, it is acceptable to attach plywood to the wooden joists. If the space is to be used as a living area, using wooden planks of a stronger and more durable wood, such as pine, is a common practice with attic retrofits. Bamboo, which may often be overlooked, could be a good choice as a stable wood for attic floors.²¹ It is important to take into consideration the support given to this flooring. In some instances, the attic flooring may not be constructed to support heavy storage or traffic flow. Therefore, there would not be sufficient support from the original structure and a renovation would require addition reinforcements.

The attic access, which can facilitate **stack effect** (discussed in Chapter 3) in a home and unconditioned attic, can also create problems for homeowners if they are trying to use the attic space. Some historic homes may just have a small rectangular access hole with no way of reaching the attic without a ladder (Figure 2.9), while others may have stairs leading to the space. Pull down ladder and hatch systems are the most common modern attic access types; however, not necessarily in historic homes. This system allows for wooden or metal stairs to be concealed within the attic hatch; these can be pulled down in order to climb up to the attic (Figure 2.10). A staircase is another common attic access type, in which a stair is built into the side of a room or hallway that

²¹ "What Are the Different Types of Attic Flooring?" *wiseGeek*, Conjecture Corporation, <http://www.wisegeek.com/what-are-the-different-types-of-attic-flooring.htm>

leads to the attic space (Figure 2.11). If creating better attic access is desired, a homeowner can change the type of access by adding a ladder or creating a set of stairs, such as a spiral staircase, to lead to the space. In historic homes, modifying the structure as little as possible is encouraged.

Insulation, the last element of a historic home's attic structural anatomy, will be discussed in Chapter 5.



Figure 2.9 Attic Access Without Ladder. Queen Anne Residence, Muncie, IN.



Figure 2.10 Attic Access Using Pull Down Ladder and Hatch Attic Access.²²

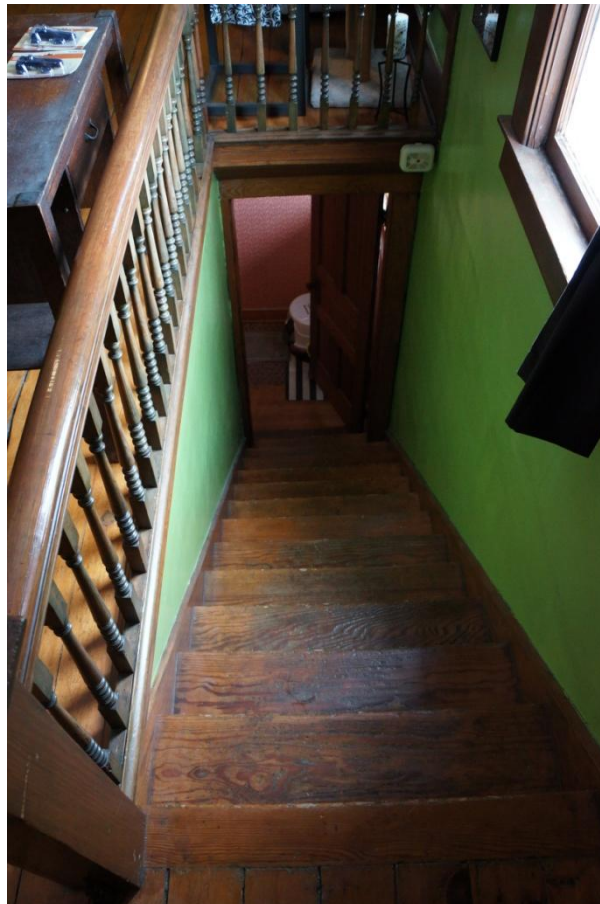


Figure 2.11 Attic Stairway. Dutch Colonial Residence. Muncie, IN.

²² Pull Down Ladder and Hatch Attic Access. <http://www.laddersattic.com/best-pull-down-attic-stairs-top-quality/>

Chapter 3: Historic Homes and Heat Flow

3.1 Heat Flow in Historic Homes

There are many reasons why homes lose heat in the winter and gain heat in the summer. The effects vary depending on climate conditions, building characteristics, building operations, and building upkeep. Homeowner education is an essential step toward energy efficiency in historic homes. While this thesis is primarily about the attic space, this chapter will explore heat flow across the entire home and how the attic fits into that picture.

A house, whether historic or modern, is always susceptible to heat gain/loss. This is due to a number of reasons: **convection**, **conduction**, **radiation**, and gaps along the **building's envelope** allowing for the transfer of heat. Typical sources of heat gain/loss in a home and how much heat flow they allow are shown in Figure 3.1.

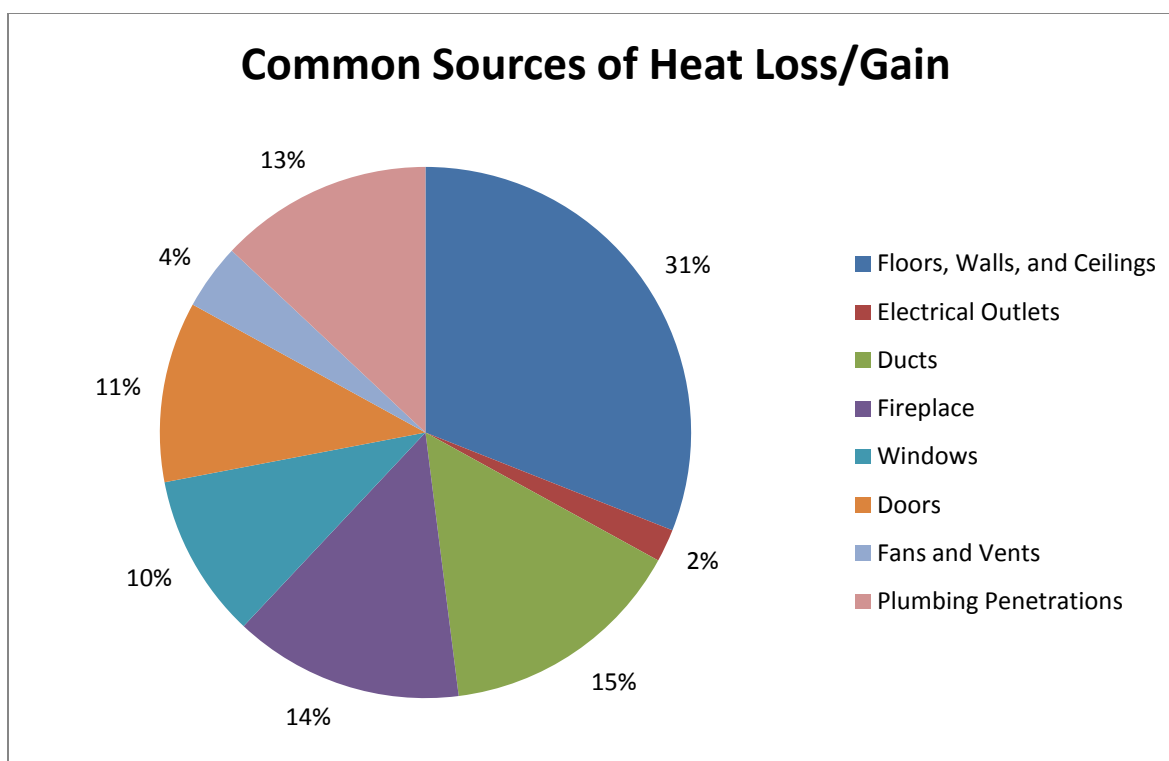


Figure 3.1 Common Sources of Heat Loss/Gain¹

In order to understand the way the transfer of heat occurs in a house, we must first look briefly at the basis for heat loss. Heat is a “form of energy that is embodied in the [vibration] activity within an atom’s structure.”² Heat has two types: sensible and latent. **Sensible heat** involves a change in temperature caused by the addition or subtraction of heat, while **latent heat** is a result of moisture content being changed by the addition or subtraction of water vapor through the action of heat. Heat flow, the loss and gain of heat across a home, is the movement of heat between substances, always from warmer to cooler. Conduction, convection, radiation, and **evaporation**, are the four types of heat flow that can be present at

¹ Common Sources of Air Leaks. Chart based on data presented by Hensley, Jo Ellen, and Antonio Aguilar. Preservation Brief 3: *Improving Energy Efficiency in Historic Buildings*. National Park Service U.S. Department of the Interior. <http://www.nps.gov/hps/tps/briefs/brief03.pdf>

² Walter Grondzik, “Heat and Heat Flow,” PowerPoint for Environmental Systems 1, Ball State University, November, 2012. <http://wtgzik.pairserver.com/courses/273sum12/273-HeatFlow.pdf>

any given time. Conduction, convection, and radiation are sensible heat transfers which impact temperature. Evaporation relates to latent heat which impacts moisture content.³ Convection and conduction, and to a lesser extent radiation, can be impeded by insulation while radiant barriers and **vapor barriers** help to reduce radiation and evaporation. However, without a tightly sealed **air barrier**, insulation can be bypassed allowing for heat gain and loss via infiltration. Figure 3.2 shows how sensible heat can move across a building's envelope.

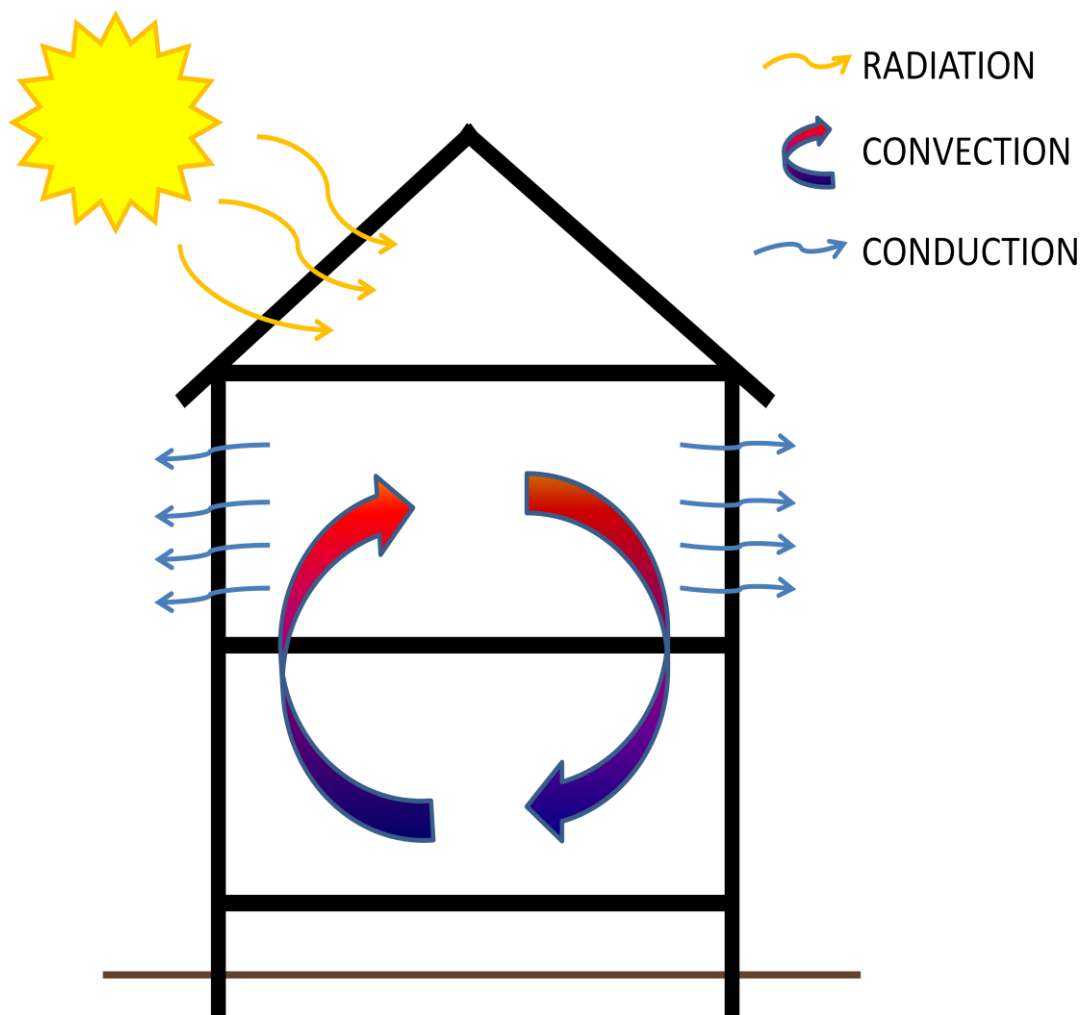


Figure 3.2 Primary Sensible Heat Transfer Elements

³ Walter Grondzik, "Heat and Heat Flow," PowerPoint for Environmental Systems 1, Ball State University, November, 2012. <http://wtgzik.pairserver.com/courses/273sum12/273-HeatFlow.pdf>.

3.2 Air Leakage

Air leakage (infiltration and exfiltration) is an important issue when dealing with heat gain/loss in a home. It can account for 5 to 40 percent of space conditioning costs within a house.⁴ In addition, air infiltration can cause discomfort to occupants because of drafts. It can also be problematic in historic homes because it is known to increase moisture movement into building systems. A number of driving forces cause air to leak into and out of a home. Pressure differences between the air inside a home and the air outside a home, resulting from wind, mechanical systems (i.e., fans for forced-air heating and cooling systems), and/or stack effect are the driving forces of concern.⁵ Of the three, stack effect can typically be the most important to address.

3.2.1 Wind

Wind can be a powerful force in terms of air leakage. When wind blows against a wall or roof, it creates a high pressure area that pushes outdoor air into the cracks of a house as well as a low pressure area on the leeward side that acts like a vacuum sucking the indoor air out the other side. As the building height increases, the force of the wind also increases.⁶ Therefore, in multi-story homes, the effect of wind pressure can be both more noticeable and more important in terms of infiltration.

⁴ John Krigger, *Residential Energy: Cost Savings and Comfort for Existing Buildings*, 2nd ed. (Helena, 2004), 67.

⁵ Jo Allen Hensley and Antonio Aguilar, *Improving Energy Efficiency in Historic Buildings*, National Park Service, U.S. Department of the Interior, <http://www.nps.gov/hps/tps/briefs/brief03.pdf>

⁶ John Krigger, *Residential Energy: Cost Savings and Comfort for Existing Buildings*, 2nd ed. (Helena, 2004), 70.

3.2.2 Mechanical Systems

Fans create a pressure difference between the supply and return sides of forced air systems in a home. If the duct system is relatively air tight, these systems should have no effect on air infiltration and exfiltration. However, if systems are unbalanced and/or not sealed correctly, they can generate air pressure driving forces that are even larger than wind or stack effect. One cause for this type of imbalance is called a “single return” or “common return” system where every room of the house has one or more supply registers that blow air into the rooms, yet there are only one or two return registers that serve the entire house. If someone closes a door, this type of system will be compromised because a room without a return register will become pressurized.⁷ This increased air pressure forces air to leak through the wall and to the outside. If this occurs in the winter months, the air will cool on its way out, depositing its moisture inside the wall.

Another cause of pressure imbalance is duct leakage. If supply duct leakage is greater than the leakage in the return ducts it will cause the house to be depressurized. If return duct leakage predominates the house will be pressurized. Exhaust fans such as those located in kitchens and bathrooms depressurize a house as they expel air to the outside. Clothes dryers typically expel an even larger amount of air and thus can result in even greater house depressurizations.

⁷ Adapted from comments provided by William W. Hill, Professor Emeritus, Ball State University, March, 2013.

3.2.3 Stack Effect

The difference in air densities between warm air inside a home and cold air on the outside creates an air pressure difference that in turn causes air to move. This is known as stack effect. The result of this driving force is that cold air is drawn into the house at the lower levels, such as a basement or **crawlspace**, where it is warmed, and then escapes through holes near the top of the house, most likely in the attic. Stack effect gets its name from the fact that the air movement resembles the flow in a chimney or smoke stack with air traveling in at the bottom and exiting or exhausting out the top. The highest pressure differences resulting from stack effect occur at the highest and lowest parts of a building. During winter at the top of the house, the pressures are positive with reference to the outside, while the bottom of the house has negative pressure with reference to the outside.⁸ The middle portion of the building, where the pressure difference between the inside and outside is zero is called the neutral pressure plane. Building enclosure holes or gaps near the neutral plane are not as significant and do not need as much attention as those in the negative or positive pressure plane.⁹ Two factors that are directly associated with these pressure differences are the temperature difference between the inside and outside of a house and the height of the house. The taller the house and the greater the temperature difference, the greater the stack effect in the house. It is also important to note that these pressures are continuous, and are, therefore, constantly occurring in a home.¹⁰

Figure 3.3 suggests how air moves through a two-story home in response to stack effect.

⁸ William W. Hill, "Dr. Bill's Famous Stack Effect Demo Box," handout for the Living Lightly Fair, Muncie, Indiana, September, 2011.

⁹ John Krigger, *Residential Energy: Cost Savings and Comfort for Existing Buildings*, 2nd ed. (Helena, 2004), 69.

¹⁰ William W. Hill, "Dr. Bill's Famous Stack Effect Demo Box," handout for the Living Lightly Fair, Muncie, Indiana, September, 2011.

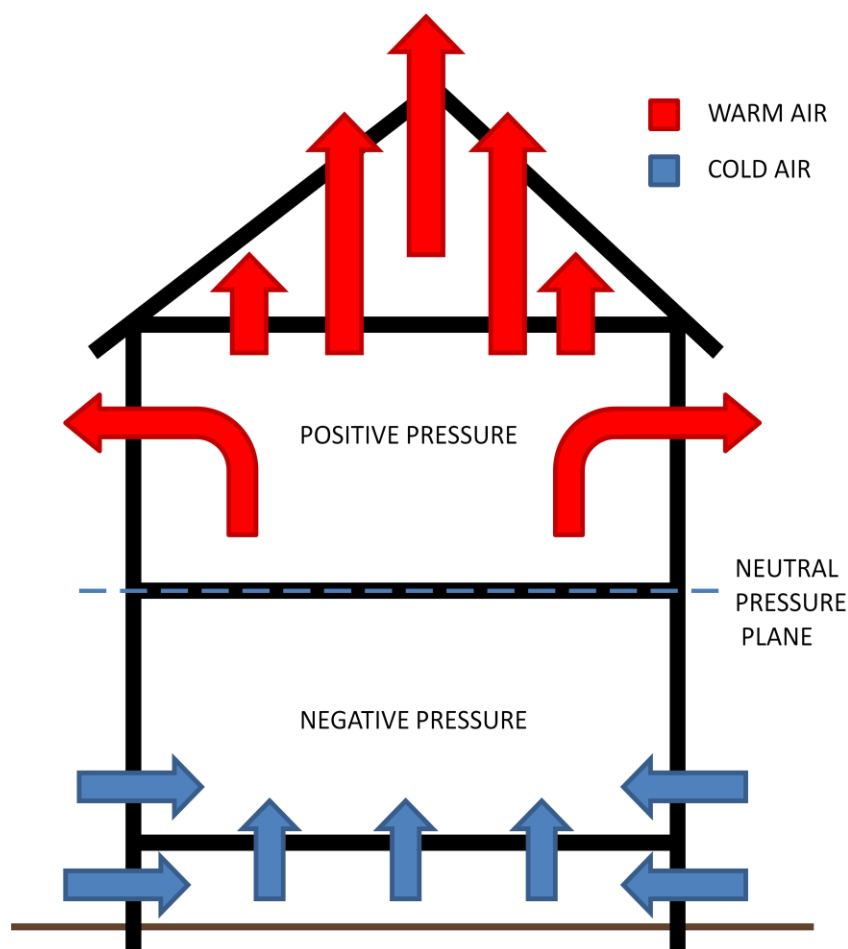


Figure 3.3 Stack Effect Diagram

There are a number of important sites around a home that allow for air leakage. Although there is a common misconception that cracks around windows and doors on the main level of the home are the biggest culprits, this is not the case. Cracks around windows and doors near the middle of the house are within or near the neutral pressure plane where the pressure difference between inside and outside is zero or near zero. This means that there is little to no driving force that would cause air to flow.¹¹ As previously noted, the pressures are highest at the top and the bottom of the house. Therefore, these locations are where the holes

¹¹ William W. Hill, "Dr. Bill's Famous Stack Effect Demo Box," handout for the Living Lightly Fair, Muncie, Indiana, September, 2011.

can be found that need to be addressed. Attic access doors, discussed in Chapter 2, are a major contributor to air leaks that normally go unnoticed. Drop down ceilings and building additions with small and seemingly inaccessible attics are another location that can be overlooked while providing large holes causing air leakage.

3.3 Heat Gain/Loss through Roofs and Walls

Air leaks through cracks and holes are not the only way in which heat flow can occur across a house. Heat is also gained or lost through the roofs and walls of a home caused by temperature differences that drive convection and conduction, and by radiation flows. Due to a home's natural convection, heat will rise into the attic. Heat will then travel through a wall or roof from a higher temperature to a lower temperature. For instance, if the temperature in a house is 70 degrees and the temperature outside is 30 degrees, the heat within the home will flow through the wall and/or roof assemblies to the lower temperature (Figure 3.4). Wall and/or roof assemblies are made of several materials that each have a different resistance to heat flow. The types of materials used within an assembly will determine the rate of heat flow in and out of a home through these assemblies.

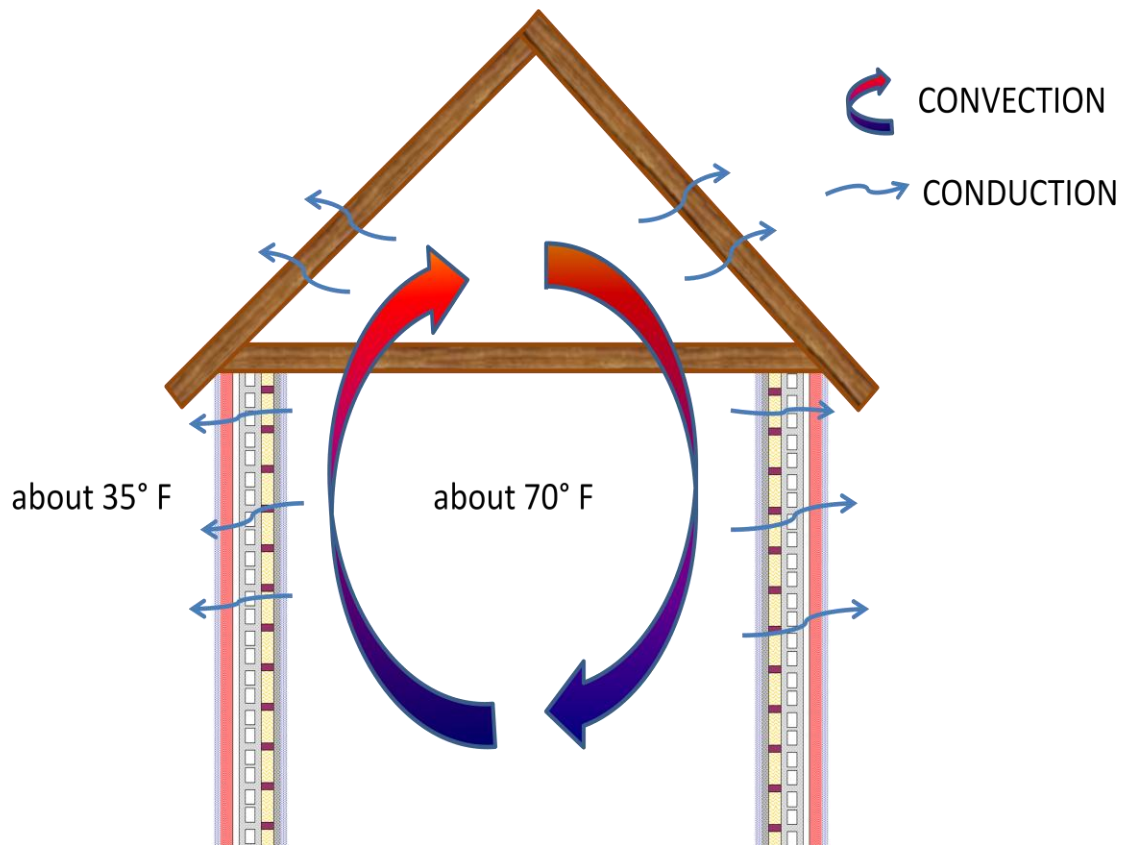


Figure 3.4 Heat Flow through Walls and Roof

3.4 Heat Gain/Loss through Windows

Another area where heat flow can occur is through windows. For attic spaces, these windows are typically in the form of dormer windows. While some heat can escape through a window assembly due to not being properly sealed, most window heat flow is due to conduction, convection and radiation. As with heat flow through walls and roofs, temperature differences drive conduction, allowing heat to flow into the area of lower temperature. Radiation, however, takes place independently of temperature differences. Because windows are transparent, radiation flows more easily through this medium as opposed to the opaque

materials of the walls.¹² Figure 3.5 depicts how conduction, convection and radiation occur through the transparent material of a window.

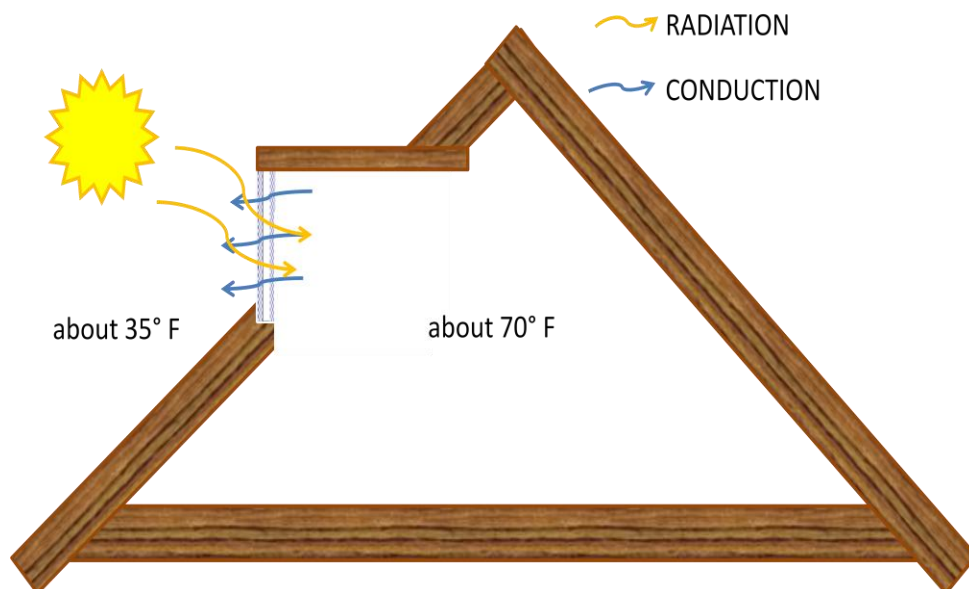


Figure 3.5 Heat Flow through Windows

3.5 Best Ways to Air- Seal an Attic to Reduce Heat Flow

Sealing air leaks is one of the most cost-effective ways to reduce heat flow (and energy waste) in a home. It is important to do this before adding any additional insulation, because most insulation material, by itself, will not provide an air barrier to block air leaks. Caulking and **weather-stripping** seams, cracks, and openings to the outside can help the sealing process.¹³ However, these small cracks and crevices are not the most substantial air leakage sites that need to be addressed. Holes between the **conditioned** space of a home and the attic, often hidden from sight, are typically responsible for some of the largest amounts of heat loss from

¹² Walter Grondzik, "Building Envelope Heat Flow," PowerPoint for Environmental Systems 1, Ball State University, November, 2012. <http://wtgzik.pairserver.com/courses/273sum12/273-EnvelopeHeat.pdf>

¹³ *Energy Savers: Tips on Saving Money & Energy at Home*, U.S. Department of Energy, http://energy.gov/sites/prod/files/energy_savers.pdf

interior to exterior. Poorly sealed attic access doors can result in significant amounts of air leakage. The key to successfully sealing air leaks within a home is to identify the air barrier (the material designed to block air flow) and have it line up with the location of the **thermal boundary** (the insulation plane). Without an air barrier, there will still be ways for air (and thus heat) to exfiltrate and infiltrate the house. While it is important to reduce air leakage, it is not advisable to seal a historic building completely.¹⁴ This is because historic homes were built to “breathe,” meaning that air and moisture can move naturally throughout the house. If a historic house was sealed entirely, this natural movement of air and moisture would be dramatically altered and could create problems associated with moisture accumulation.

¹⁴ National Park Service, “Weatherization: Eliminate Air Infiltration,” Technical Preservation Services, <http://www.nps.gov/tps/sustainability/energy-efficiency/weatherization/air-infiltration.htm>

Chapter 4: Keeping Integrity in Mind

4.1 Integrity and Its Importance

The previous chapters of this thesis have been geared toward gaining background knowledge of single family homes, how they are constructed, and how heat flow occurs within them. More important, however, is how modifications to a home, in particular to an attic, might affect the historic integrity, or authenticity, of a home residing in a historic district. In most cases historic integrity is based upon the authenticity of a property's historic identity. Typically, the most recognizable way of distinguishing whether or not a home has its historic identity and integrity is by the surviving physical characteristics of the structure. In order to be listed on the **National Register of Historic Places**, buildings are assessed for their historic integrity by seven qualities: location, design, setting, materials, workmanship, feeling, and association.¹ For the purposes of this thesis, only the qualities of design, materials, workmanship, and feeling, collectively referred to under the term integrity, will be used in order to look at how much of the original fabric remains and is unharmed.

¹ U.S. Department of the Interior, *National Register Bulletin: How to Complete the National Register Registration Form Part A*, (Washington, D.C., 1997), 4.

4.2 Is it Reversible? Is it Harmless?

Two of the biggest concerns for preservationists when discussing alteration to a historic property, exemplified within the Secretary of the Interior's Standards and Guidelines, are whether or not a modification can be undone, or reversed, and whether a modification does harm to the structure or material of the building. Whether or not an alteration is permanent can be a large factor in determining if the integrity remains sound. In most cases, if an alteration can be made that does not jeopardize the historic character of a building and can be later removed, if desired, it is generally accepted.

4.3 Secretary of Interior's Standards and Guidelines for Rehabilitation

In order to help educate the public on the meaning and importance of historical integrity as well as to respond to the public's need for guidance for renovating historic buildings, the National Park Service and the Secretary of the Interior published a series of **design guidelines** and standards. These are combined into a document known as "The Secretary of the Interior's Standards for the Treatment of Historic Properties." Within this document, four treatment approaches—preservation, **rehabilitation**, **restoration**, and reconstruction—were developed in order to assist those interested in renovations of historic structures. These four approaches vary in flexibility, but all use historic integrity as a basis for their standards and guidelines. Because this thesis is focused on retrofitting attics of historic homes for more contemporary uses rather than simply storage, the treatment approach that is most applicable here is "rehabilitation." The three other treatments (preservation, restoration, and reconstruction) are outside the scope of this thesis and will not be discussed.

Rehabilitation, as defined by the Secretary of Interior, can be used for historic buildings needing repair, alterations, or additions. This approach also allows the home owner the most flexibility for making desired changes. Furthermore, “rehabilitation” factors in the opportunity to make possible an efficient contemporary use through alterations or changes. It is sometimes referred to as an adaptive use approach because it involves assigning a new use to a space (such as an attic).² There are ten standards for rehabilitation as well as a set of guidelines to be used in order to maintain a structure’s integrity. The Standards require that if a space be changed, it should have a **compatible** use, maintain its historic character, and retain its finishes and construction techniques, with elements being repaired rather than replaced to the extent possible. They also note that new additions or alterations should be done in a way that allows for their removal in the future without destroying any historic materials. These Standards are included as Appendix A.

A set of guidelines (included as Appendix B) has also been established that further explains acceptable renovation treatments for historic structures. Although highly recommended, these general guidelines are not considered requirements and do not provide case-specific advice. Beginning with the least invasive options, recommended and not recommended treatments are given to aid the homeowner. Sections of these guidelines include planning, maintenance, windows, **weatherization** and insulation, HVAC and air circulation, solar

² Norman Tyler, Ted J. Ligibel, and Ilene R. Tyler, *Historic Preservation: An Introduction to Its History, Principles, and Practice*, 2nd ed. (New York and London: W.W. Norton & Company, Inc., 2009), 197.

technology, wind power, cool roofs and green roofs, site features and water efficiency, and day lighting.³

As thorough and informative as these standards and guidelines are, not all requirements and suggestions are applicable to the subject of this thesis, attic retrofits. These standards were not created with a finished attic space in mind. Because attics are typically not ornamented and are without finished woodwork and walls, there may not be significant character-defining aspects that need to be addressed. That said, the structure of an attic (including the openness of the space and the way the roof was framed) might be considered a character-defining feature. Therefore, these guidelines are still seen as applicable not only because the attic is an important part of a historic structure, but also because the construction of the exposed framing of an attic defines its space and should be **preserved** as much as possible to retain historic integrity. As for application to Muncie's historic districts, only exterior modifications are reviewed under local ordinance (further discussed in Chapter 5). While not enforced under law, these standards are regarded as "best practice" and therefore should be considered by an owner of a historic home regardless of legal technicalities.

4.4 Guidelines and Regulations for Historic Districts

In some cases, local historic districts will have regulations and guidelines for their historic houses as well. The Emily Kimbrough Historic District (EKHD) in Muncie, Indiana, is a good example of this. The EKHD's document, which is also concerned with maintaining historic integrity, reinforces the guidelines set forth by the Department of the Interior, but is specifically

³ Anne E. Grimmer, Jo Ellen Hensley, Liz Petrella, and Audrey T. Tepper, *Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*, (Washington, D.C.: U.S. Department of the Interior, 2011), 2-23.

designed for the needs of those living within the historic district. The EKHD Guidelines outline local procedures and special design criteria to be used in alterations being done to the historic structures within the district. How strictly such guidelines are enforced depends on the historic district and varies widely.

As this chapter indicates, it is imperative to maintain the integrity of historic structures throughout historic districts like the ones in Muncie, Indiana. If integrity was not a significant focus for the owners of historic homes, the properties would lose their uniqueness, their craftsmanship, their history. Without guidance on how to retrofit attics for their contemporary needs, many homeowners could use inappropriate methods for altering spaces and use incorrect insulation practices. In the next chapter, **appropriate** and inappropriate methods are discussed. While there is no absolute or perfect solution to such alterations, energy efficiency and integrity can go hand in hand as long as homeowners have options that they can choose from to best suit their needs.

Chapter 5: Retrofit Alternatives for Attics in

Historic Homes

There are several ways to go about retrofitting an attic in a historic home. As noted in the previous chapter, however, the importance of retaining a historic home's integrity should be an ever-present thought while deciding which retrofit route to take. In this chapter, five alternatives ways of retrofitting an attic are presented, along with their respective benefits and disadvantages. At the end of the chapter, each alternative will then be scored in terms of historic integrity, energy efficiency, and cost. Before discussing the different alternatives for an attic retrofit in an historic home, a brief overview of insulation's role in historic homes is given.

5.1 Overview

During the mid-1970s, energy price increases started to raise public concern about home energy efficiency. Over time, changes have occurred to houses to make them more energy efficient. For example, some builders of wood frame houses began using two-by-six inch studs spaced two feet apart rather than the traditional two-by-four inch studs spaced sixteen inches apart. This was done in order to install thicker and more effective insulation.¹

¹ Barbara J. Howe, Dolores A. Fleming, Emory L. Kemp, and Ruth A. Overbeck, *Houses and Homes: Exploring Their History*, (Lanham, 1997), 130.

In an opaque wall or roof assembly, insulation makes up the thermal boundary that separates the conditioned (heated or cooled) living spaces of a home from unconditioned or exterior spaces.² Insulation serves one primary function: to reduce the heat flow into and out of buildings. Insulation's **resistance** to heat flow is quantified by its **R-value**, with the "R" standing for thermal resistance.³ The higher the R-value, the greater the resistance to heat flow. The effective "R-value" of a wall assembly can be affected by a number of things including material density, coverage of insulation, water content, and air moving around, within, and through the insulation. To be effective, insulation must be continuous and dense enough to prevent air currents from flowing through it easily.⁴ If correctly installed and with sufficient R-value, insulation can dramatically decrease heating and cooling costs for a home. Adding insulation, but only after sealing up the cracks and gaps in the building's envelope, is an essential part of modifying an attic for future use.

5.2 The Blank Canvas—What's Already There

Attics of historic houses vary in size and structure, but have similar characteristics in terms of construction (Figure 5.1). Some attics may have a small access door that can only be reached by ladder, while others may have stairs that lead up to the space. In some instances, there may not be covering over the floor joists, but in others wooden planks are assembled to create a walk-able floor. Unless altered, most if not all of these spaces are unconditioned. In an unconditioned attic, it is common to see loose-blown or loose-fill insulation installed directly into the attic space between the floor joists.

² John Krigger, *Residential Energy: Cost Savings and Comfort for Existing Buildings*, 2nd ed. (Helena, 2004), 55.

³ Dan Chiras, "All About Insulation," *Mother Earth News* (Winter, 2008): 56-61.

⁴ John Krigger, *Residential Energy: Cost Savings and Comfort for Existing Buildings*, 2nd ed. (Helena, 2004), 96.

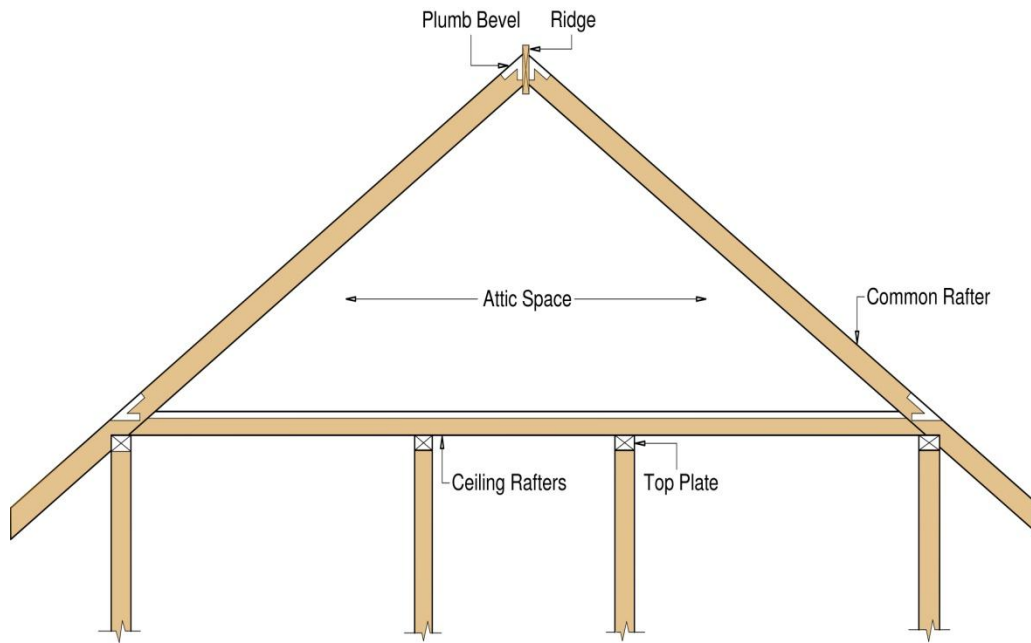


Figure 5.1 Simplified Attic Space⁵

5.3 Alternative 1: Knee Walls

The first alternative, a common method in converting attic space to be better utilized, is by using drywall to section off the shorter spaces of an attic that are harder to use (Figure 5.2). The space in the attic where the floor meets the roof rafters is not easily usable because of the lack of head room. Therefore, when an attic is turned into a conditioned space, people install short walls, referred to as **knee walls**, that close off the area where the ceiling and floor meet, creating a side attic. The framework for the knee walls is built first, typically built about four or five feet tall.⁶ The book, *New Living Spaces*, gives a more in-depth look at the construction of knee walls. After the framework for the knee walls is installed, **fiberglass batts**, or even rigid foam insulation, are put in place to insulate the space. The batts are laid between the wall

⁵ Susan Leigh Smith, *Simplified Attic Space*, 2015, Muncie

⁶ Time-Life Books, ed. *New Living Spaces: Home Repair and Improvement*, (Alexandria, 1977), 32.

studs, floor joists, or roof rafters, as well as between the studded knee wall frameworks.

Drywall should then be placed on the knee walls, up the slant of the roof and ceiling to finish the space.

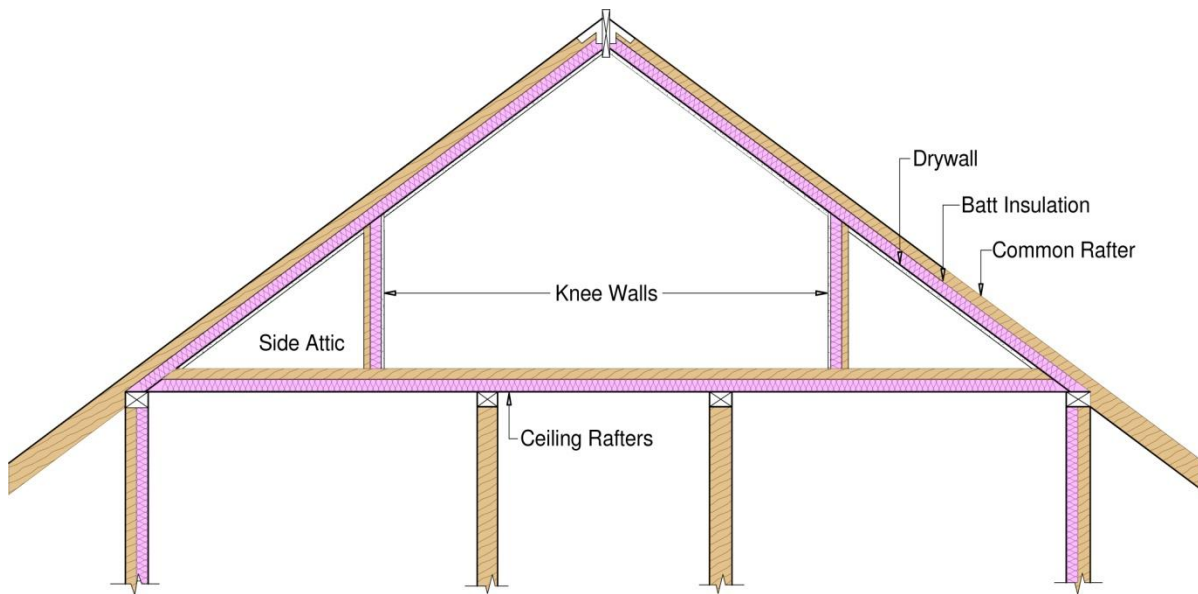


Figure 5.2 Insulation of Attic Space with Knee Wall Construction⁷

The benefits of this approach are few. In regards to the Secretary of the Interior's Standards for Rehabilitation (discussed in Chapter 4), this approach may be appropriate due to the fact that the renovation could be easily removed at a later date if necessary. The fiberglass batt insulation materials are not only removable, but should also not damage the historic fabric into which they are placed. Covering up the roof rafters, depending on how the attic is constructed, may slightly take away from the integrity of the space by both changing the feel of the space and by covering up the construction and "bones" of the attic. Aside from that, this approach would have minimal adverse effects on the historic integrity of the home. The

⁷ Susan Leigh Smith, *Insulation of Attic Space with Knee Wall Construction*, 2015, Muncie

Standards of Rehabilitation take into account that spaces do have to accommodate changes over time and therefore, would allow this type of alteration if as much of a structure's integrity as possible could be saved.

In terms of costs, this alternative would be moderately priced allowing for the project to be completed with less expense up front. On the other hand, other costs could accumulate in terms of energy use in the long run. This is because of a common lack of proper air sealing, which can create a significant problem with heat loss/gain. Attic insulation will not be useful if it is not air sealed and will be affected the stack effect discussed in Chapter 3. This problem can be resolved with the solution in Alternative 2 below. Another problem that could occur with knee walls is if the homeowner needed access to the side attic. Access doors in a knee wall are not usually insulated properly and may not be sealed well when closed. This could also reduce the attic insulation's effectiveness due to the hole in the air barrier (or pressure boundary). Although this way of retrofitting an attic is common, it does not produce the best result.

5.4 Alternative 2: Sealing the Key Juncture

The second alternative uses the same construction as the conventional knee wall approach, however, with the addition of careful attention to insulation and air sealing. The main issue is the Key Juncture. This term is used for the space between the attic floor under the knee wall and the ceiling below; it is not taken into account and commonly overlooked.⁸ This area provides an opportunity for air leakage from the conditioned attic space, as well as the rooms below that are connected to the attic. Correct sealing of this space is crucial in order to maintain an air barrier that matches up with the thermal barrier. To ensure that a continuous

⁸ William W. Hill, "Houses with Knee Walls and Side Attics," Powerpoint, November, 2012.

thermal and air barrier is achieved, not only will this space need to be air sealed, but additional insulation will need to be installed to the floor of the side attic as well as to the back of the knee wall. If the attic is not insulated correctly, heat and air will escape through the side attics. Figure 5.3 shows how insulating the knee walls and the key juncture will create a continuous air and thermal barrier. Figure 5.4 is a house that was improperly insulated allowing heat to escape through the side attic, melting the snow/frost on the roof.

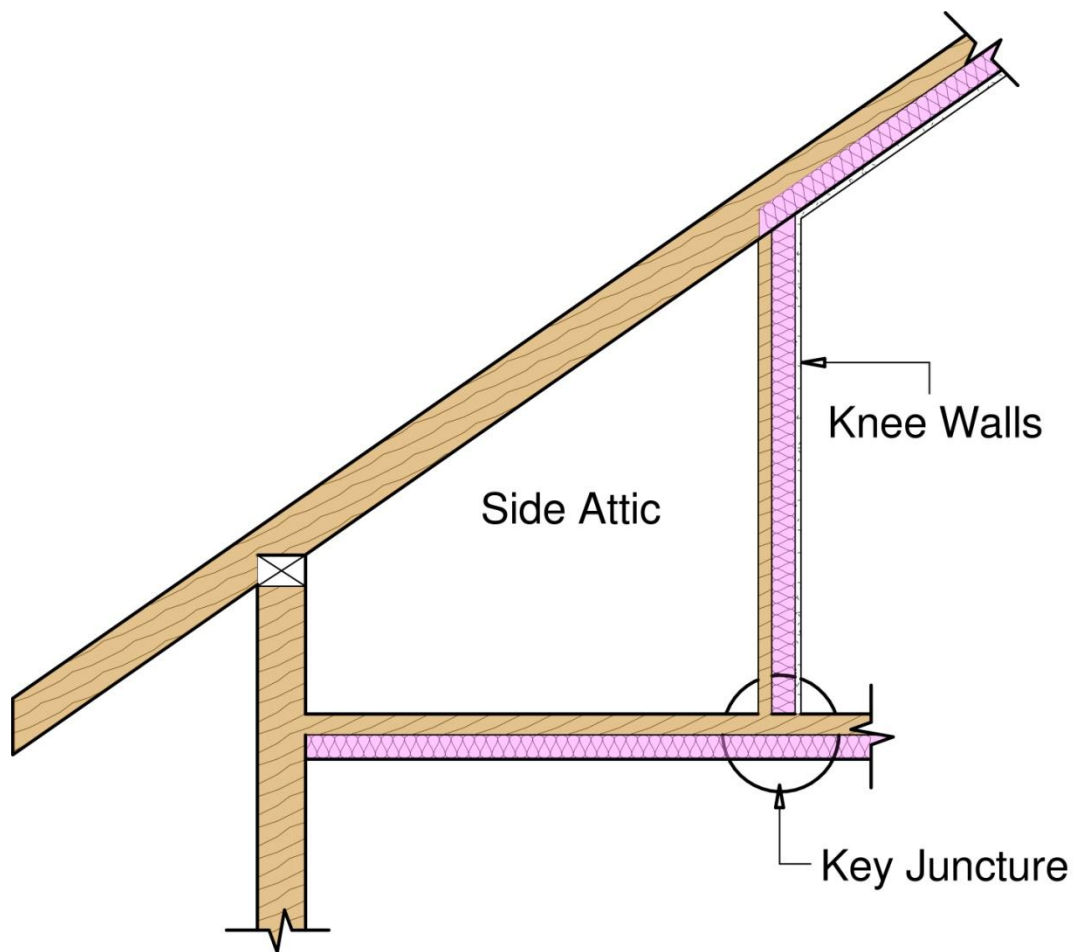


Figure 5.3 Insulation at the Key Juncture⁹

⁹ Susan Leigh Smith, *Insulation at the Key Juncture*, 2015, Muncie



*Figure 5.4 Heat Loss through Improper Attic Insulation.*¹⁰

There are two ways that a home owner might solve this dilemma. One solution is to use dense-packed cellulose insulation to ensure the space at the key juncture is air tight and insulated thoroughly. Weatherization professionals do this by using high pressure machines to pack the cellulose into this space tight enough to create a type of plug that will help seal the attic space from heat gain/loss and air leakage.¹¹ With dense-packed cellulose, you can also create insulation “pillows” by stapling house wrap to the floor and walls and then dense-packing the “pillow” with cellulose. These pillows cover the back portion of the knee wall in the side attic, as well as any duct work that may be run through the space. There should also be a place to run return ducts within the side attic to ensure that the pressure will not change if someone accesses the room. Another solution is to install dimensional lumber or rigid **foam**

¹⁰ William W. Hill, “Houses with Knee Walls and Side Attics,” Powerpoint, November, 2012.

¹¹ William W. Hill, “Delineating Attic Retrofit Alternatives,” June, 2013.

boards that are specifically cut to fit between every space between joists, followed by careful caulking around all of the intersections to provide an air tight space.

The benefit of this alternative is that the owner will reduce energy consumption. However, this approach is more labor intensive and thus the initial costs would be greater. In terms of historic integrity, it could be argued as an acceptable application because it does not significantly damage the historic material. The insulation of the key juncture, however, could not be removed without damaging the historic materials. As with the first alternative, the drywall would alter the appearance of the attic space, but could be removed at a later date.

5.5 Alternative 3: Insulating the Slant

The third alternative goes a step further. Instead of careful attention to insulating the key juncture, this approach moves the thermal and pressure boundaries to the underside of the roof deck. Because the building envelope for this method moves from the attic floor to the roof, insulation needs to be installed on the underside of the roof. This is referred to as insulating the slant (Figure 5.5).¹²

¹² William W. Hill, "Houses with Knee Walls and Side Attics," Powerpoint, November, 2012.

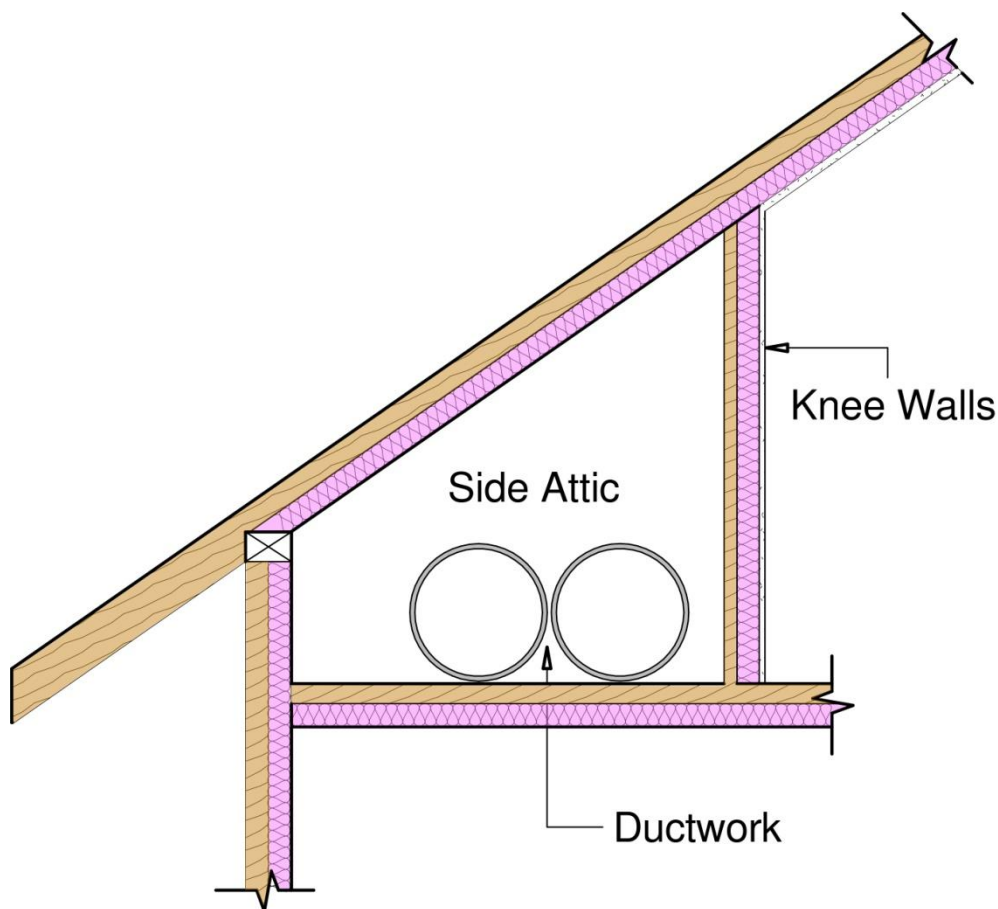


Figure 5.5 Insulating the Slant¹³

When insulation is placed under the roof, all ventilation openings in the attic and the wall and roof rafter intersections must be sealed. They are no longer needed to ventilate the attic for it is now being used as a conditioned space and would have an air barrier. Rigid foam or batt insulation placed in between the rafters is a common method of insulation for this type of configuration.¹⁴

¹³ Susan Leigh Smith, *Insulating the Slant*, 2015, Muncie

¹⁴ Jo Allen Hensley and Antonio Aguilar, *Improving Energy Efficiency in Historic Buildings*, National Park Service U.S. Department of the Interior, <http://www.nps.gov/hps/tps/briefs/brief03.pdf>

This alternative has the benefit of having a side attic that is within the conditioned space. This allows for supply and return ducts to be run in an insulated space and will therefore save energy. Significant moisture problems can occur if the air barrier does not match up with the thermal barrier. If there is no air barrier on the interior surface of the insulation, water vapor will migrate through and condense into liquid. Fortunately, dense-packed cellulose can be used to prevent this problem by acting to impede air flow.¹⁵ It is important to note that an air barrier alone will not prevent vapor movement and thus, a vapor retarder would also be needed.

5.6 Alternative 4: Spray Foam

The fourth alternative is common in new construction but has been only occasionally applied in attics of historic homes. It uses spray foam to coat the underside of the roof deck and the inside of the exterior sheathing on the gable ends (Figure 5.6). This type of insulation creates both a thermal boundary and a pressure boundary making it easier to completely air seal the space. The foam can be thick enough to meet R-value code-requirements, but fiberglass batts may also be added between the foam and drywall. For example, first a thin coat of spray foam would be applied, followed by the fiberglass batts to fill the remaining cavity space, and then drywall placed over that to create the finished space. The drywall acts as the thermal barrier and the foam provides insulation, as well as an air barrier and vapor retarder while the fiberglass batts provide additional R-value.¹⁶

¹⁵ Dr. William W. Hill, "Delineating Attic Retrofit Alternatives," June, 2013.

¹⁶ Ibid.

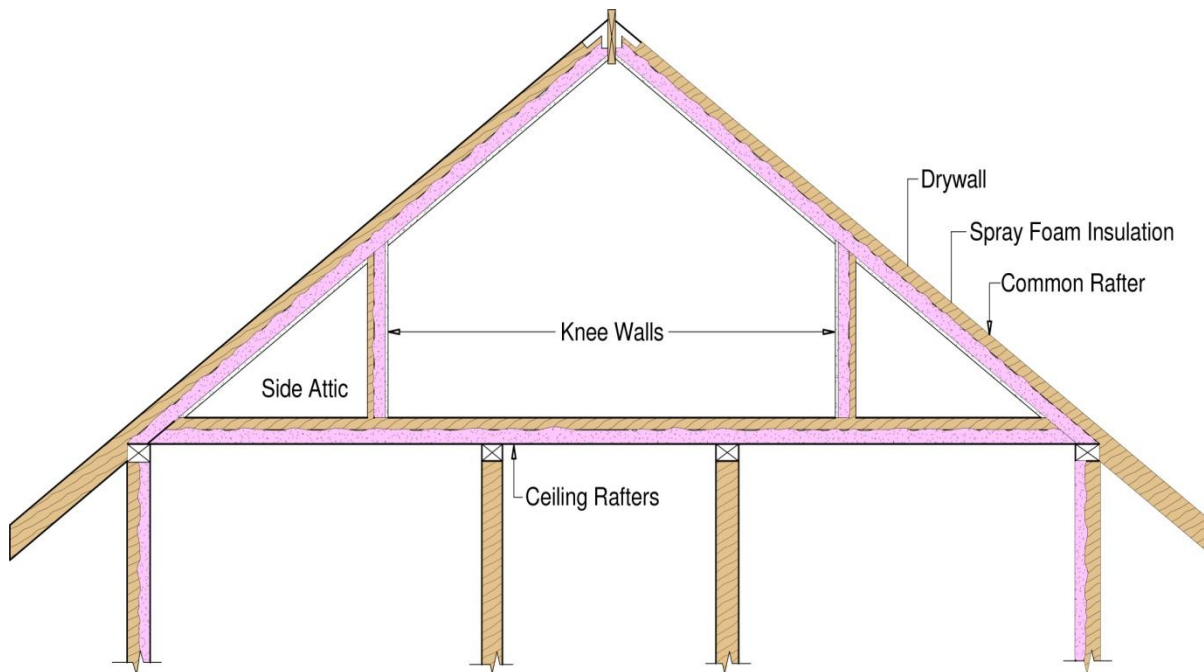


Figure 5.6 Spray Foam Insulation Approach¹⁷

Caution must be used, however, to make sure that the insulation does not allow any spaces where heat could escape by conduction, such as through **thermal bridging** when a material (such as a rafter) allows for heat flow to **bypass** the thermal barrier. Figure 5.7 shows winter heat loss from thermal bridging through rafters.

¹⁷ Susan Leigh Smith, *Spray Foam Insulation Approach*, 2015, Muncie



Figure 5.7 Effects of Thermal Bridging¹⁸

In terms of historic integrity, this alternative is lacking. The spray foam insulation is irreversible due to the invasive nature of the foam; it enters the pores of the wood when it is applied. Not only this, but the spray foam would permanently alter the appearance and craftsmanship of the attic construction. The rafters and joists would be completely covered as well. This type of insulation does the most harm to the structure and is not consistent with the meaning of integrity. While this approach would seemingly be cost-effective, it is not the best to use in a historic home.

5.7 Alternative 5: Above Roof Insulation

If most of the insulation options discussed above do not seem like ideal applications for historic homes, is there any way that efficiency and integrity can co-exist? The simple answer is yes. There is no perfect solution to rehabilitating historic houses, but technological advances

¹⁸ Joseph Lstiburek, “BSI-063: Over-roofing—Don’t Do Stupid Things,” Building Science Insights, [buildingscience.com](http://www.buildingscience.com/documents/insights/bsi-063-over-roofing), <http://www.buildingscience.com/documents/insights/bsi-063-over-roofing>

and the never-ending need for adaptive reuses for historic homes are continuing to evolve and allowing owners of historic houses to find ways to make their homes more efficient.

What if an owner of an historic house wanted to retain the look and feel of an attic space by keeping the rafters exposed? The solution to this would be the fifth alternative, above roof insulation. While this approach is still relatively new, it presents a union between energy efficiency and historic integrity.

Above roof insulation is just that—insulation applied above the roof deck. This moves the insulation from the inside of the attic to underneath the shingles, allowing for the rafters and wood construction of the attic to be left exposed. To install this “above roof insulation” the current roofing material should be removed, leaving the roof deck exposed. As Figure 5.8 shows, an adhesive membrane is attached to the roof deck as the new air barrier for the attic. Rigid insulation is applied over the top of the membrane, using whatever R-value is required for the particular climate zone. Muncie, Climate Zone 5, requires a minimum R-value of R-20 of continuous insulation.¹⁹ Two layers of staggered rigid foam rather than one layer of the necessary thickness is recommended because it serves as better protection from moisture penetration.²⁰ After the insulation is applied, an engineered structural panel similar to plywood known as Oriented Strand Board (OSB), is added and works as a nail base for the shingles. This is followed by another membrane for water protection and finally the shingles. Because the attic would now be considered a conditioned space, it no longer needs air ventilation to the

¹⁹ “Building Envelope Requirements for Climate Zone 5,” *ANSI/ASHRAE/IESNA Standard 90.1-2010*, ASHRAE, <https://www.ashrae.org/standards-research--technology/standards--guidelines>

²⁰ Martin Holladay, “Creating a Conditioned Attic,” *Musings of an Energy Nerd*, Green Building Advisor.com, <http://www.greenbuildingadvisor.com/blogs/dept/musings/creating-conditioned-attic>

outside. The 2006 International Residential Code (IRC) Section R806.4 allows for no ventilation as long as “air-impermeable” insulation is used. Rigid foam insulation meets this standard.²¹

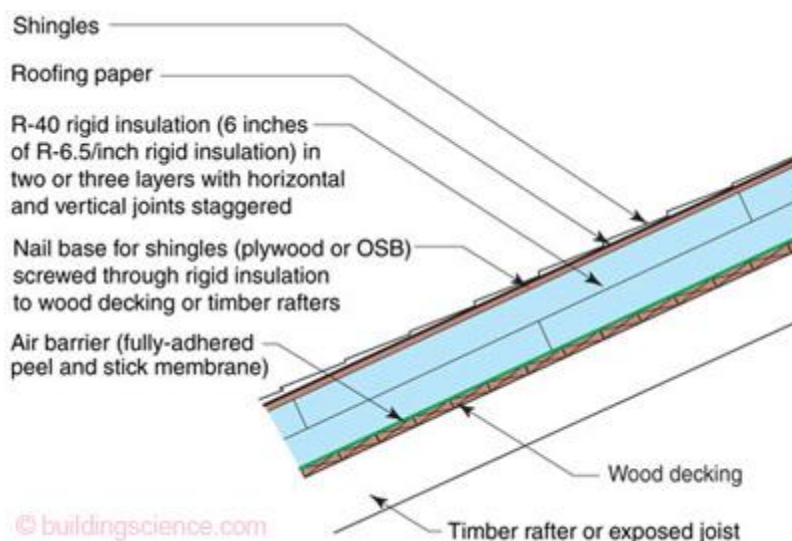


Figure 5.8 Above Roof Insulation²²

This application of insulation allows the owner of a historic house to keep the integrity of the interior attic space. The interior material is not harmed or altered because nothing is being adhered to it. The overall space and feel of the attic is seemingly unaltered due to the fact that the rafters are exposed rather than being covered up with drywall. The craftsmanship of the construction is also retained and can be appreciated. Not to mention, the exposed wood rafters can also be aesthetically pleasing to some historic home owners. Yet another benefit to this type of approach is that it helps eliminate thermal bridging through the rafters for better energy efficiency. This approach removes the potential for moisture problems inherent in the fourth alternative and provides a good air and thermal boundary.

²¹ Martin Holladay, “Creating a Conditioned Attic,” *Musings of an Energy Nerd*, Green Building Advisor.com, <http://www.greenbuildingadvisor.com/blogs/dept/musings/creating-conditioned-attic>.

²² Joseph Lstiburek, “BSI-036: Complex Three Dimensional Airflow Networks,” *Building Science Insights*, buildingscience.com, <http://www.buildingscience.com/documents/insights/bsi-036-complex-three-dimensional-air-flow-networks>

While this may seem like the perfect approach, there are also some disadvantages that should be addressed. For one, this type of modification to the roof and insulation treatment brings into question exterior integrity. While this approach allows the home owner to retain the integrity of the interior, the exterior is being altered considerably, including having to remove the current shingles. Therefore, this application is ideally done when a roof is significantly damaged and needs to be replaced. Another problem posed by this type of application is that now the shingles will be raised several inches above where the original shingles once were, and thus, could change the appearance of the roof if not done correctly.

In order to hide the thickness of the added above roof insulation, new trim details and framing may need to be added. Figure 5.9 illustrates how Joseph Lstiburek solved this problem by designing new reveals for the roof edge. By extending the roof deck and creating a new crown molding, fascia, and soffit, the built up roof can be discreet. This in turn allows the historic exterior to maintain its appearance. Without removing the original reveals, it also permits reversibility and a record of the changes completed. Because this alternative requires careful planning and craftsmanship, it can be significantly more expensive than the more conventional approaches.

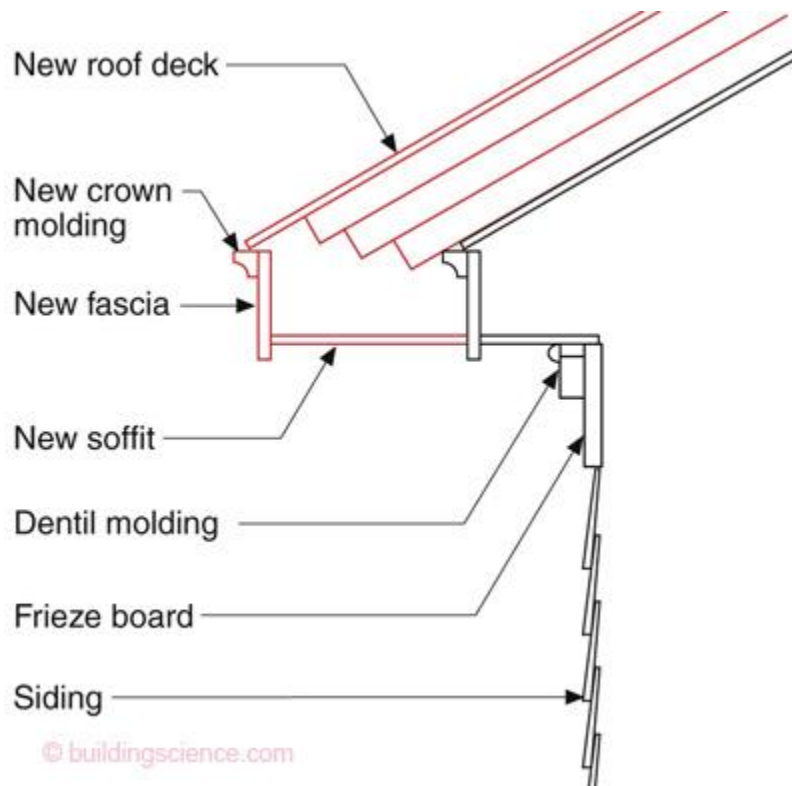


Figure 5.9 New Construction Reveals²³

Although such alteration to the exterior may be seen as inappropriate to some preservationists, the benefits of the retained interior integrity seemingly outweigh any negatives if done sympathetically. This option is a perfect hybrid of energy efficiency and integrity, although not the most economically viable alternative for some families. Overall, this approach blends the needs of the modern family to be more energy efficient while not overlooking the value of a historic structure.

²³ Joseph Lstiburek, “BSI-063: Over-roofing—Don’t Do Stupid Things,” Building Science Insights, buildingscience.com, <http://www.buildingscience.com/documents/insights/bsi-063-over-roofing>.

5.8 Other Things To Consider

For any of the above retrofit alternatives, there are benefits and disadvantages when looking at integrity. Because attics are not typically finished, there may not be a large concern about whether or not changing the space would be character altering for the historic structure. However, a bigger obstacle in terms of a retrofit would be if a homeowner wanted to create a new staircase to the attic. This could impact significant space on the floor below, causing a more significant change to the integrity of the rest of the house. If the changes are sympathetic to the original architecture, though, they would most likely be appropriate.

Windows are another area that might be overlooked during a retrofit. If there are windows in an attic it is important that they be analyzed to ensure that they are in proper working condition. If there are thermal or air leakage problems with a window, the window should be restored and re-glazed rather than replaced. This will provide for energy efficiency in a cost-effective way by sealing leaks without having to buy an expensive and typically less durable replacement window. According to a recent study by the National Trust for Historic Preservation, retrofit windows are not only comparable to replacement windows in terms of efficiency, but they also have a better return on investment.²⁴ In addition, it may be advisable to place a single-glazed storm window on the interior or exterior of the window. This can increase a single-pane window's thermal resistance by 50 percent.²⁵ However, if the window

²⁴ Preservation Green Lab, *Saving Windows, Saving Money: Evaluating the Energy Performance of Window Retrofit and Replacement*, National Trust for Historic Preservation, http://www.preservationnation.org/information-center/sustainable-communities/green-lab/saving-windows-saving-money/120919_NTHP_windows-analysis_v3lowres.pdf

²⁵ Jo Allen Hensley and Antonio Aguilar, *Improving Energy Efficiency in Historic Buildings*, National Park Service U.S. Department of the Interior, <http://www.nps.gov/hps/tps/briefs/brief03.pdf>

has deteriorated beyond repair and restoration is impractical, a replacement window may be installed **in kind**. Replacing a window in kind means that the new window matches the historic window's size, design, muntin profile, color, number of panes, and reflective qualities.

Replacement should only be used as a last resort.

As this chapter explains, there are several different alternatives and considerations for retrofitting an attic in a historic home. Table 5.1 indicates how each alternative ranks in terms of historic integrity, energy efficiency, and cost. The rank of 1 to 5 is from lowest to highest. Some alternatives are more suitable to the historic integrity of a home than others. However, as long as the modifications and alterations are sympathetic to the original architecture, they will typically be acceptable.

Name of Alternative	Costs	Historic Integrity	Energy Efficiency
	1	3	2
	2	3	3
	3	3	4
	3	1	4
	5	4	4

Table 5.1 Retrofit Alternative Scores

Chapter 6: Regulations and Incentives for Historic Home Attic Modifications

Until this point, this thesis has presented basic knowledge of the history and structure of historic homes, as well as attic-related heat flow and energy use reduction solutions. In this chapter, considerations that are needed for a homeowner to get started on an attic retrofit are explained. These steps include certain codes, standards, and guidelines that have been put in place to protect the owner, the historic home, and the community.

First and foremost, it is essential to seek assistance and advice from professionals, to ensure that the modifications are done correctly. Professionals could include preservationists, energy auditors, engineers, architects, etc. Developing a clear plan of what needs to be done, as well as setting realistic goals for energy savings, is important. Another component that should be factored in is the fact that different organizations have created regulations to be followed while retrofitting a historic home. It is essential that a historic home owner be aware of such regulations and requirements throughout the retrofit process.

6.1 Energy Audit

It is important, when modifying an existing attic to become a more habitable and useful space, that this be done in an energy efficient way. Doing this correctly may actually reduce the overall energy consumption of the house even though the living area is now larger. In order for a retrofit to be successful in terms of energy efficiency, one step that should be taken before implementing any measures is an energy audit. An energy audit should be completed to evaluate the current energy use of the building and identify any deficiencies within the home, either in the building envelope or the mechanical systems. The National Park Service provides a Do-It-Yourself Home Energy Audit checklist that takes a homeowner through a simple energy audit.¹ A local utility company may offer a simple energy audit for free or for a small fee. For example, Vectren Energy in Muncie offers an energy assessment free of charge to any of their customers. Customers can also log into their account online and do their own online energy audit.² However, a more in-depth audit will require a professional energy auditor.

The first thing an energy auditor should do is document the current energy use patterns and history, including the billing history, number of residents, how the building is used, and what type of fuel is consumed. Existing insulation, mechanical systems, and major appliances are documented and inspected, and the existing R-values of different walls, ceilings, etc. are determined. Ideally, a **blower door** is used to determine the whole house air leakage. Even more importantly, a well-trained auditor will also use a blower door to perform “pressure diagnostics” in order to determine which spaces of the house are inside the pressure boundary,

¹ “Weatherization: Energy Audit,” *Technical Preservation Services*, National Park Service, <http://www.nps.gov/tps/sustainability/energy-efficiency/weatherization/energy-audit.htm>

² “Online Energy Audit,” Vectren Live Smart, https://www.vectren.com/Save_Energy/Online_Energy_Audit.jsp

which is normally (and should be) the same as the conditioned space of the house. A blower door test, Figure 6.1, entails using a large calibrated fan to either depressurize or pressurize a house in order to measure the whole house infiltration.³

Thermal imaging, or infrared scanning, is another tool that allows the auditor to see the locations of heat loss. This can be especially useful in conjunction with a blower door. After these tests are performed, the auditor will produce a report of the findings and will include recommendations on what the next steps to a more energy efficient home will be. These recommendations might include air sealing, increasing insulation, general repairs, or even replacements in some circumstances. After these changes are made, it is important to retest the performance of the house to make sure any problems that were found during the audit have been fixed. Tests such as the blower door and thermal imaging can help a homeowner to fix problem areas in the building envelope allowing for a more comfortable and conditioned building before an attic retrofit on a historic home is completed.

³ "Weatherization: Energy Audit," *Technical Preservation Services*, National Park Service, <http://www.nps.gov/tps/sustainability/energy-efficiency/weatherization/energy-audit.htm>



Figure 6.1 Blower Door Used for Energy Audit⁴

6.2 Energy and Building Codes

Along with the energy audit, several things must be taken into consideration while modifying an attic space of a historic home. Building, energy, and other code requirements must be met, though enforcement of these codes varies widely across the country and within each state. To help make sure a home is in compliance with such energy code requirements, software programs like *REScheck* are available to builders, designers, and homeowners. While not typically used by the average homeowner, *REScheck* can be downloaded at the U.S.

Department of Energy (DOE) website (<http://www.energycodes.gov/rescheck>). The International

⁴ Jo Ellen Hensley and Antonio Aguilar, "Preservation Brief #3: Improving Energy Efficiency in Historic Buildings." National Park Service. U.S. Department of the Interior. <http://www.nps.gov/hps/tps/briefs/brief03.pdf>.

Building Code (IBC) is required by the state of Indiana and enables a homeowner to figure out fire egress requirements and load occupancy of an attic turned into a living space. Other organizations that have specific requirements and codes include the International Residential Code and the Indiana Administrative Code discussed below.

6.2.1 *Climate Zones*

Building energy code requirements are climate dependent. Figuring out which climate zone a house is in will help determine how much insulation is required for the attic. For example, Muncie, according to the DOE Climate Zone Map shown in Figure 6.2, is located in Climate Zone 5, a Cold climate area. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) provides a recommended R-value chart based on these climate zones to help determine the amount of insulation that should be installed for commercial buildings and residential buildings of three or more stories. According to ASHRAE Standard 90.1-2010, the building envelope requirement for Climate Zone 5 for residential attics is R-38, but if the insulation is entirely above the roof deck (discussed in Chapter 5), the requirement is R-20 of continuous insulation.⁵ Because this Standard is based off of commercial buildings and residential buildings of three or more stories, it should only be used as a guidance tool rather than use for a typical residential property of less than three stories.

⁵ "Building Envelope Requirements for Climate Zone 5," *ANSI/ASHRAE/IESNA Standard 90.1-2010*, ASHRAE, <https://www.ashrae.org/standards-research--technology/standards--guidelines>.



Figure 6.2 DOE Climate Zone Map⁶

6.2.2 International Residential Code (IRC)

The IRC is a document (by the International Code Council (ICC)) that compiles code regulations for one- and two-family dwellings and townhouses. It is meant to be a model residential code that will safeguard the public health and safety and establishes minimum requirements for such homes through its provisions.⁷ According to Section R806.1, roof ventilation is required for enclosed attics where the ceilings are applied directly to the underside of the roof rafters. This means, if a homeowner were to follow the first alternative modification method (conventional knee walls) proposed in Chapter 5, there would need to be a space for roof ventilation between the insulation and the roof deck above. However, for unvented attic assemblies like that of the second alternative (above roof insulation), Section R806.4 does not require ventilation as long as the attic space is completely contained within the building's thermal envelope. In Climate Zone 5, air-impermeable insulation of R-20 shall be a

⁶ Jo Ellen Hensley and Antonio Aguilar, "Preservation Brief #3: Improving Energy Efficiency in Historic Buildings." National Park Service. U.S. Department of the Interior. <http://www.nps.gov/hps/tps/briefs/brief03.pdf>.

⁷ International Code Council, "2009 International Residential Code for One- and Two- family Dwellings," [icc.irc.2009.pdf](http://www.icc.org)

vapor retarder or have a vapor retarder coating/covering underneath the insulation to provide condensation control.⁸ The International Energy Conservation Code (IECC) created a website in which homeowners, builders, designers, etc., could look up the specific types of materials that are approved for use in commercial and residential properties. The link to that website is provided in Appendix C. The local building official (in Muncie, the Building Commissioner's Office) is responsible for the enforcement of these requirements.

6.2.3 *Indiana Administrative Code (IAC)*

The Indiana Administrative Code (IAC) is a compilation of all permanent administrative rules in the state of Indiana. It is updated frequently on the Indiana General Assembly's website along with repeals of the rules and effective dates. It is important to check this site for the latest updates before beginning any alterations to a house. Title 675, Fire Prevention and Building Safety Commission, states the codes and rules that must be complied with. Some of the articles under Title 675 include plumbing, fire escapes, electrical, and construction and building codes. Article 19 in particular, deals with energy conservation codes.⁹ This includes required R-values for building insulation. This website for the Indiana Administrative Code can be found in Appendix C.

⁸ International Code Council, "2009 International Residential Code for One- and Two- family Dwellings," [icc.irc.2009.pdf](#), 431.

⁹ Indiana General Assembly, "Title 675 Fire Prevention and Building Safety Commission," IR Database: Indiana Administrative Code, http://www.in.gov/legislative/iac/iac_title?iact=675.

6.3 Guidelines

6.3.1 *Secretary of Interior's Standards and Guidelines*

The National Park Service administers the enforcement of the Standards that were discussed in Chapter 4. The Guidelines (Appendix B), however, are general and are to provide guidance rather than requirements. Although the Guidelines do not always apply to interior projects, they do represent “best practice,” and therefore should be consulted when rehabilitating or altering a historic structure. Seeking the advice of historic preservation professionals is recommended to ensure compliance with the Standards and Guidelines. It may also be helpful to consult with students of the Historic Preservation Program at Ball State University for guidance.

6.3.2 *Historic District Regulations*

On a more local level, historic districts will also sometimes have guidelines and regulations. When this is the case, a review process must be completed in order for alterations or additions to be done to a historic house. The district protects the integrity of its houses by requiring property owners to obtain an approved **Certificate of Appropriateness (COA)**. Changes that require this approved certification include changes in material (such as roofing), additions, as well as any alterations to the structure’s appearance, to name a few. In Muncie, historic home owners in districts like the Emily Kimbrough Historic District (EKHD) must obtain this certificate from the Muncie Historic Preservation and Redevelopment Commission before the Building Commissioner will issue a permit. According to Bill Morgan, Muncie’s former Historic Preservation Officer, a COA is only necessary if alterations affect the exterior appearance of the building. Therefore, if one wanted to do above roof insulation (Alternative 5

discussed in Chapter 5), a COA would be required. A COA would also be required if bedrooms were planned for an attic space and the windows needed to be enlarged to meet code for emergency egress.¹⁰ Supporting documentation is required to obtain a COA for all major rehabilitation work.¹¹ According to the EKHD Guidelines Volume 1, photos showing existing conditions, as well as samples of materials and drawings of how the structure will look after the work is completed should be included in the documentation. If an original element is being recreated, such as the **cornice** reveals for above roof insulation, documentation showing what had previously existed (usually the current condition) is also needed. COA applications are available at the Muncie Office of Community Development (City Hall, 300 North High Street, Muncie, IN). After an application and its supporting documentation are submitted, it will be discussed at the MHPRC's monthly meeting to be approved or denied. If work proceeds without a COA, a stop work order will be posted by the Building Commissioner and a violation could result in a fine of \$1,000 per day.¹²

6.4 Building Commissioner Permits

In Delaware County, permits from the building commissioner are required for several purposes, whether this is construction, demolition, electrical, plumbing, or HVAC.¹³ Depending on the type of alteration and amount of rehabilitation desired for an attic space, one or a combination of these permits would be required. A building permit is required for any

¹⁰ Bill Morgan, email message to author, June 19, 2013.

¹¹ "Historic Preservation & Redevelopment Guidelines for The Emily Kimbrough Historic District Volume 1," Emily Kimbrough Neighborhood Development Committee, http://www.muncie-ecna.org/Upload/EKNDC/EKNDC_Historic_Preservation_Guidelines_Vol_1.pdf

¹² Ibid.

¹³ "Required Permits by Building Commissioner," Delaware County, Indiana, <http://www.co.delaware.in.us/departments/division.php?fDD=5-295>

structural modifications to a house. This includes increasing the structural load of the attic if it were previously designed only for light storage. If any electrical work is to be installed, as would certainly be the case in retrofitting an attic into habitable space, an electrical permit will need to be obtained. Also, a plumbing permit would be required if a home owner wished to include a bathroom in this space. Other applications that require a permit can be found at the Delaware County, Indiana website provided in Appendix C.

It is the responsibility of the homeowner to obtain these permits or direct the contractor to do so by acting as the owner's agent. If construction is started without a permit, a fine of \$700 could be assessed.¹⁴

6.5 Tax Incentives

6.5.1 Federal

The Federal Historic Preservation Tax Incentives program is administered by a partnership between the National Park Service (NPS), the Internal Revenue Service (IRS), and the State Historic Preservation Offices (SHPO). It encourages private sector rehabilitation of historic buildings by offering a 20% credit to income-producing structures, such as rental properties. To be certified for federal funds and for historic preservation tax credits, a rehabilitation project must meet the Secretary of the Interior's Standards for Rehabilitation.¹⁵ This ensures that the retrofit will be consistent with the historic character of a structure. The rehab project must also cost more than the cost of the house prior to the rehabilitation, be

¹⁴ "Required Permits by Building Commissioner," Delaware County, Indiana, <http://www.co.delaware.in.us/departments/division.php?fDD=5-295>

¹⁵ Anne E. Grimmer, Jo Ellen Hensley, Liz Petrella, and Audrey T. Tepper, *Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings*, (Washington, D.C.: U.S. Department of the Interior, 2011), vi.

certified as a contributing structure of a historic district, and be used for income-producing purposes for at least five years. Generally, owner-occupied residential properties are not eligible for the federal rehabilitation tax credit.¹⁶ However, if the house is used as rental property or a home-business, it could still be possible to take advantage of the credits. The NPS websites for federal tax credits are listed in Appendix C.

There are also some energy tax incentives that may be available to historic home owners. The Tax Incentives Assistance Project (TIAP) helps owners to utilize federal income tax incentives for energy efficient products and technologies. Some of these incentives include increases in insulation levels, energy efficient windows, as well as air sealing the building envelope and ducts. The credit available to homeowners is capped at \$200-500 and applies to purchases made within the years 2012 and 2013. Applicants must use IRS Form 5695 and make changes compliant with the 2009 IECC.¹⁷

6.5.2 State

The Department of Natural Resources (DNR) and the Division of Historic Preservation and Archaeology (DHPA) administer a program that makes tax credits available to Indiana taxpayers who wish to rehabilitate their historic residence. This incentive, the Residential Historic Rehabilitation Credit is available to those who pay Indiana State Income Tax and allows for 20% credit of the total qualified rehabilitation cost of a project. Conditions for qualification include that the property must be in Indiana, at least 50 years old, on the Indiana Register of

¹⁶ "Eligibility Requirements," *Technical Preservation Services*, National Park Service, <http://www.nps.gov/tps/tax-incentives/before-apply/eligibility-requirements.htm>

¹⁷ "Consumer Tax Incentives," The Tax Incentives Assistance Project, www.energytaxincentives.org, http://www.energytaxincentives.org/consumers/insulation_etc.php.

Historic Sites and Structures, used as the taxpayer's principal residence, and be approved by the DHPA. The rehabilitation costs must exceed \$10,000 to qualify.¹⁸ Other conditions of the program apply and can be viewed, along with the application, at the Indiana State Government website provided in Appendix C.

In addition to this, there may also be some state property tax incentives for rehabilitating historic structures. Instead of raising money for the project, this incentive freezes the assessed value of property for a short period of time, inhibiting the property taxes from skyrocketing as soon as the alterations are completed.¹⁹

As for state residential energy incentives, the DOE funds a compilation of sources of information on state, local, and federal incentives called the Database of State Incentives for Renewables and Efficiency (DSIRE).²⁰ A homeowner can search the incentives and rebates by state. For Indiana, DSIRE lists several rebate, loan, and grant programs that may be applicable to certain projects. Again, the website for the DSIRE database is provided in Appendix C.

6.5.3 Local

In regards to local help for historic home owners, there is not much assistance to be had. Bill Morgan states that many historic buildings have had help with Housing and Urban Development (HUD) funds through the Community Development Office. In the past, both HOME Investment Partnership and Community Development Block Grant funds have been used. However, HUD is focused on affordable housing and therefore, puts restrictions on

¹⁸ "Residential Historic Rehabilitation Credit," *DNR*, IN.gov, <http://www.in.gov/dnr/historic/3679.htm>.

¹⁹ Bill Morgan, email message to author, June 20, 2013.

²⁰ "Home," *Database of State Incentives for Renewables & Efficiency*, U.S. Department of Energy, <http://www.dsireusa.org/>.

owner or tenant incomes. The older neighborhoods are beginning to hit a saturation point for low- and moderate-income housing. Everyone would prefer to see more single family rehabs, which would not qualify for HUD dollars. Another setback is that HUD funding has been declining over the recent years, allowing less and less to be awarded.

Conclusion

An attic in a historic home can be a blank canvas for a homeowner to utilize in a way to suit his/her needs, whether it is to create an extra bedroom for a growing family or make an office space for an entrepreneur. When alterations to this space are made, it is important to keep integrity of the structure in mind as well as the need for greater energy efficiency. This guide to retrofitting an attic in a historic home was intended to give a home owner essential knowledge that one would need in order to successfully complete a retrofit.

Heat loss and heat gain are significant issues that need to be addressed when completing a retrofit. Knowing how this heat flow occurs and what steps to take to reduce such energy loss is an important factor when conditioning an attic space for new use. This thesis explained some of the ways heat flow occurs within a home.

Several alternatives to modify an attic space—conventional knee wall, sealing the key juncture, insulating the slant, spray foam insulation, and insulating above the roof deck, were investigated to show the most cost effective, energy efficient, or integrity based options. While each alternative has its pros and cons, some alternatives are more suitable to the historic integrity of a home than others. However, as long as the modifications and alterations are sympathetic to the original architecture, they will typically be acceptable. Every house is

different as well as the needs of each owner of a historic home, but maintaining a balance between integrity and modern use can be achieved with careful planning and a love for historic structures.

An overview of guidelines and regulations was also given to provide an owner of a historic home with the right tools to start an attic retrofit. While this information is beneficial to a home owner, it is always recommended to seek the advice and help of a professional before starting such an extensive project.

Appendix A

A Portion of the Secretary of the Interior's Standards for Rehabilitation of Historic Buildings

The standards, as stated in the 1997 revisions of "The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings"¹ are as follows with commentary that explains how each standard can be applied to attics in historic houses:

1. "A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment."

While this standard's meaning focuses primarily on that of the entire structure's use, it can also be applied for room by room interpretation. For example, if an owner of a historic home wanted to change the use of the attic from its original purpose of storage or empty space, the new use should be compatible and not overpower the space or change its character. Appropriate new uses could be a bedroom or office, as long as these new uses do not detract from the integrity of the space.

¹ Grimmer, Anne E., Jo Ellen Hensley, Liz Petrella, and Audrey T. Tepper. "Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings." (Washington, D.C.: U.S. Department of the Interior, 2011). <http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf>

2. "The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided."

When dealing with the house in its entirety, the historic features and character of a space are more clearly defined. As for an attic, the assembly of the rafters and beams may be the only feature that helps define the space. Therefore, it is important to maintain the historic material and the openness of the room in an attic space.

3. "Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken."

This standard is mainly focused on exterior appearance within an environment and does not particularly apply to an attic space. However, any additions or alterations to the space should not look original, yet should be compatible with the space. For example, putting historic stained glass in an attic window when there was none originally would not be appropriate.

4. "Most properties change over time, those changes that have acquired historic significance in their own right shall be retained and preserved."

Again, this standard may not be applicable to attic space, but if there was some alteration that had existed in an attic for a long period of time and had attained its own significance within the space, it should be preserved as such.

5. "Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved."

As previously mentioned, the assembly of the rafters and beams of an attic are a significant aspect of the space as well as the house as a whole. This standard suggests that this is an example of craftsmanship and should be retained to maintain integrity of the space.

6. "Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence."

This standard mainly applies to wood windows in relation to repairing them if damaged rather than replacing them. It can be applied to attic spaces that have deteriorating windows or other elements such as floor boards or wood beams.

7. "Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible."

This refers to exterior treatments, including the cleaning of brick, and would not apply to renovations in attic spaces.

8. "Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken."

In most cases, this too will not apply to attics in the historic homes and would instead be applicable to the surrounding site and environment of the structure.

9. "New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment."

Although this standard is focused on exterior appearance of new construction, it is important to note that alterations should also not destroy historic materials and integrity of the structure.

10. "New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired."

As discussed in Chapter 5, preservationists insist that any alterations (or new construction) made to a historic house should be able to be removed in the future if desired. This is sometimes referred to as reversibility of the changes taking place.

These standards may be applied to all historic houses, whether or not they are listed on the National Register. However, these standards are not enforced. The preservation community

understands that in all historic homes, updates and modifications are necessary for an ever changing American family. That is not to say that these standards should not be taken into consideration in order to preserve the beauty and history of a historic home. While there may not be a large concern for preserving an attic space in a home, it is important to remember that the attic is one of the only places in a historic home that is generally untouched. The exposed construction of an attic allows the owner, as well as anyone working on the home, to better understand how the house was built as well as an easier way to address any problems with the building's envelope. Not only this, but due to the craftsmanship put into these historic homes, every space should be appreciated rather than just overlooked and replaced.

Appendix B

The Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings

The guidelines, as shown in the 1997 revisions of “The Secretary of the Interior’s Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings” from <http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf> are accompanied by illustrations. For the purpose of this Appendix, just the Recommended v. Not Recommended tables are as follows:

1. Planning

Recommended	Not Recommended
Forming an integrated sustainability team when working on a large project that includes a preservation professional to ensure that the character and integrity of the historic building is maintained during any upgrades.	Omitting preservation expertise from a sustainability project team.
Analyzing the condition of inherently-sustainable features of the historic building, such as shutters, storm windows, awnings, porches, vents, roof monitors, skylights, light wells, transoms and naturally-lit corridors and including them in energy audits and energy modeling, before planning upgrades.	Ignoring inherently-sustainable features of the existing historic building when creating energy models and planning upgrades.

Identifying ways to reduce energy use such as installing fixtures and appliances that conserve resources, including energy efficient lighting or energy efficient lamps in existing light fixtures, low-flow plumbing fixtures, sensors and timers that control water flow, lighting and temperature, before undertaking more invasive treatments may negatively impact the historic building.	
Prioritizing sustainable improvements, beginning with minimally invasive treatments that are least likely to damage historic building material.	Beginning work with substantive or irreversible treatments without first considering and implementing less invasive measures.

2. Maintenance

Recommended	Not Recommended
Maintaining historic buildings regularly to preserve historic fabric and maximize operational efficiency.	Delaying maintenance treatments which may result in the loss of historic building fabric or decrease the performance of existing systems or features.
Retaining and repairing durable historic building materials.	Removing durable historic building materials and replacing them with materials perceived as more sustainable; for instance, removing historic heart pine flooring and replacing it with new bamboo flooring.
Using environmentally- friendly cleaning products that are compatible with historic finishes.	Using cleaning products potentially harmful to both historic finishes and the environment.
Using sustainable products and treatments, such as low VOC paints and adhesives and lead-safe paint removal methods, as much as possible, when rehabilitating a historic building.	

3. Windows

Recommended	Not Recommended
Maintaining windows on a regular basis to ensure that they function properly and are completely operable.	Neglecting to maintain historic windows and allowing them to deteriorate beyond repair with the result that they must be replaced.
Retaining and repairing historic windows when deteriorated.	Removing repairable historic windows and replacing them with new windows for perceived improvement in energy performance.
Weather stripping and caulking historic windows, when appropriate, to make them weather tight.	
Installing interior or exterior storm windows or panels that are compatible with existing historic windows.	Replacing repairable historic windows with new insulated windows.
Installing compatible and energy-efficient replacement windows that match the appearance, size, design, proportion and profile of the existing historic windows and that are also durable, repairable, and recyclable, when existing windows are too deteriorated to repair.	Installing incompatible or inefficient replacement window units that are not durable, recyclable or repairable when existing windows are deteriorated beyond repair or missing.
Replacing missing windows with new, energy efficient windows that are appropriate to the style of historic building and that are also durable, repairable and recyclable.	
Retrofitting historic windows with high performance glazing or clear film, when possible, and only if the historic character can be maintained.	
Retrofitting historic steel windows and curtain-wall systems to improve thermal performance without compromising their character.	
Installing clear, low-emissivity (low-e) glass or film without noticeable color in historically clear windows to reduce solar heat gain.	Retrofitting historically clear windows with tinted glass or reflective coatings that will negatively impact the historic character of the building.

Installing film in a slightly lighter shade of the same color tint when replacing glazing panels on historically dark tinted windows to improve day lighting.	Introducing clear glazing or a significantly lighter colored film or tint than the original to improve day lighting when replacing historically dark tinted windows.
Maintaining existing, reinstalling or installing new, historically appropriate shutters and awnings.	Removing historic shutters and awnings or installing inappropriate ones.
Repairing or reopening historically operable interior transoms, when possible, to improve air flow and cross ventilation.	Covering or removing existing transoms.

4. Weatherization and Insulation

Recommended	Not Recommended
Using a variety of analytical tools, such as a comprehensive energy audit, blower door tests, infrared thermography, energy modeling or daylight modeling, to gain an understanding of the building's performance and potential before implementing any weatherization or retrofit treatments.	Implementing energy-retrofit measures without first diagnosing the building's performance and energy needs
Developing a weatherization plan based on the results of the energy analysis of the building's performance and potential.	
Eliminating infiltration first, beginning with the least invasive and most cost-effective weatherization measures, such as caulking and weather stripping, before undertaking more invasive weatherization measures.	Undertaking treatments that result in loss of historic fabric, for example, installing wall insulation that requires removing plaster, before carrying out simple and less damaging weatherization measures.
Understanding the inherent thermal properties of the historic building materials and the actual insulating needs for the specific climate and building type before adding or changing insulation.	

Insulating unfinished spaces, such as attics, basements and crawl spaces, first.	Insulating a finished space, which requires removing historic plaster and trim, before insulating unfinished spaces.
Using the appropriate type of insulation in unfinished spaces and ensuring the space is adequately ventilated.	Using wet spray or other spray-in insulation that is not reversible or may damage historic materials.
	Adding insulation in cavities that are susceptible to water infiltration.
Ensuring that air infiltration is reduced before adding wall insulation.	Insulating walls without first reducing air infiltration.
Installing appropriate wall insulation, only if necessary, after lower impact treatments have been carried out.	Installing wall insulation that is not reversible and that may cause damage to historic building materials.
	Installing insulation on the exterior of a historic building, which results in the loss of historic materials and may alter the proportion and relationship of the wall to the historic windows and trim.
Removing interior plaster only in limited quantities and when absolutely necessary to install appropriate insulation.	Removing all interior plaster to install appropriate insulation.
Replacing interior plaster-removed to install insulation- with plaster or gypsum board to retain the historic character of the interior, and in a manner that retains the historic proportion and relationship of the wall to the historic windows and trim.	Replacing interior plaster- removed to install insulation- with gypsum board that is too thick and that alters the historic proportion and relationship of the wall to the historic windows and trim.
Reinstalling historic trim that was removed to install insulation.	Replicating trim rather than retaining and reinstalling historic trim that is repairable.

5. Heating, Ventilating and Air Conditioning (HVAC) and Air Circulation

Recommended	Not Recommended
Retaining and maintaining functional and efficient HVAC systems.	Replacing existing HVAC systems without testing their efficiency first.
Upgrading existing HVAC systems to increase efficiency and performance within normal replacement cycles.	Replacing HVAC systems prematurely when existing systems are operating efficiently.
Installing an energy efficient system that takes into account whole building performance and retains the historic character of the building and site when a new HVAC system is necessary.	Installing an inefficient HVAC system or installing a new system based on pre-retrofit building performance when a smaller system may be more appropriate.
Supplementing the efficiency of HVAC systems with less energy-intensive measures, such as programmable thermostats, attic and ceiling fans, louvers and vents, where appropriate.	
Retaining or installing high efficiency, ductless air conditioners when appropriate, which may be a more sensitive approach than installing a new, ducted, central air-conditioning system that may damage historic building material.	Installing through-the-wall air conditioners, which damages historic material and negatively impacts the building's historic character.
	Installing a central HVAC system in a manner that damages historic building material.
Installing new mechanical ductwork sensitively or using a mini-duct system, so that ducts are not visible from the exterior and do not adversely impact the historic character of the interior space.	Installing new mechanical ductwork that is visible from the exterior or adversely impacts the historic character of the interior space.
Leaving interior ductwork exposed where appropriate, such as in industrial spaces, or when concealing the ductwork would destroy historic fabric.	Leaving interior ductwork exposed in highly-finished spaces where it would negatively impact the historic character of the space.
Leaving interior ductwork exposed and painting it, when concealing it would negatively impact historic fabric, such as a historic pressed metal ceiling.	Leaving exposed ductwork unpainted in finished interior spaces, such as those with pressed metal ceilings.

Placing HVAC equipment where it will operate effectively and efficiently and be minimally visible and will not negatively impact the historic character of the building or its site.	Placing HVAC equipment in highly visible locations on the roof or on the site where it will negatively impact the historic character of the building or its site.
Commissioning or examining the performance of the HVAC system and continuing to examine it regularly to ensure that it is operating efficiently.	Installing a new HVAC system without commissioning or testing its efficiency after installation.
Investigating whether a geothermal heat pump will enhance the heating and cooling efficiency of the building before installing one	Installing a geothermal heat pump without evidence that it will improve the heating and cooling efficiency of the building.
	Installing a geothermal system where there is a significant landscape or where there are archeological resources that could be damaged.

6. Solar Technology

Recommended	Not Recommended
Considering on-site, solar technology only after implementing all appropriate treatments to improve energy efficiency of the building, which often have greater life-cycle cost benefit than on-site renewable energy.	Installing on-site, solar technology without first implementing all appropriate treatments to the building to improve its energy efficiency.
Analyzing whether or not solar technology can be used successfully and will benefit a historic building without compromising its character or the character of the site of the surrounding historic district.	Installing a solar device without first analyzing its potential benefit or whether it will negatively impact the character of the historic building or site or the surrounding historic district.
Installing a solar device in a compatible location on the site or on a non-historic building or addition where it will have minimal impact on the historic building and its site.	Placing a solar device in a highly-visible location where it will negatively impact the historic building and its site.
Installing a solar device on a historic building only after other locations have been explored and determined infeasible.	Installing a solar device on the historic building without first considering other locations.

Installing a low profile solar device on the historic building so that it is not visible or only minimally visible from the public right of way: for example, on a flat roof and set back to take advantage of a parapet or other roof feature to screen solar panels from view; or on a secondary slope of a roof, out of view from the public right of way.	Installing a solar device in a prominent location on the building where it will negatively impact its historic character.
Installing a solar device on the historic building in a manner that does not damage historic roofing material or negatively impact the building's historic character and is reversible.	Installing a solar device on the historic building in a manner that damages historic roofing material or replaces it with an incompatible material and is not reversible.
	Removing historic roof features to install solar panels.
	Altering a historic, character-defining roof slope to install solar panels.
	Installing solar devices that are not reversible.
Installing solar roof panels horizontally- flat or parallel to the roof- to reduce visibility.	Placing solar roof panels vertically where they are highly visible and will negatively impact the historic character of the building.

7. Wind Power- Wind Turbines and Windmills

Recommended	Not Recommended
Considering on-site, wind-power technology only after implementing all appropriate treatments to the building to improve energy efficiency, which often have greater life-cycle cost benefit than on-site renewable energy.	Installing on-site, wind-power technology, without first implementing all appropriate treatments to the building to improve energy efficiency.
Analyzing whether wind-power technology can be used successfully and will benefit a historic building without compromising its character or the character of the site or the surrounding historic district.	Installing wind-powered equipment without first analyzing its potential benefit or whether it will negatively impact the character of the historic building or the site or the surrounding historic district.

Installing wind-powered equipment in an appropriate location on the site or on a non-historic building or addition where it will not negatively impact the historic character of the building, the site or the surrounding historic district.	Placing wind-powered equipment on the site where it is highly visible when it is not compatible with the historic character of the site.
Installing wind-powered equipment on the historic building without damaging the roof or walls or otherwise negatively impacting the building's historic character.	Installing wind-powered equipment on the historic building in a manner that damages the roof, compromises its structure or negatively impacts the building's historic character.
	Removing historic roof features to install wind-powered equipment, such as wind turbines.
	Installing wind-powered equipment on the historic building that is not reversible.
	Installing wind-powered equipment on the primary façade of a historic building where it is highly visible.
Investigating off-site, renewable energy options when installing on-site wind-power equipment would negatively impact the historic character of the building or site.	

8. Roofs- Cool Roofs and Green Roofs

Recommended	Not Recommended
Retaining and repairing durable, character-defining historic roofing materials in good condition.	Replacing durable, character-defining historic roofing materials in good condition with a roofing material perceived as more sustainable.
Analyzing whether a cool roof or a green roof is appropriate for the historic building.	
Installing a cool roof or a green roof on a flat-roofed historic building where it will not be visible from the public right of way and will not negatively impact the building's historic character.	Installing a cool roof/green roof without considering if it will be highly visible from the public view and will negatively impact the building's historic character.

Selecting appropriate roofing materials and colors when putting a new cool roof on the historic building.	Installing a cool roof that is incompatible in material or color with the historic building.
Ensuring that the historic building can structurally accommodate the added weight of a green roof and sensitively improving the structural capacity, if necessary.	Adding a green roof that would be too heavy and would damage the historic building or supplementing the structural capacity of the historic building in an insensitive manner.
Ensuring that the roof is water tight and that roof drains, gutters and downspouts function properly before installing a green roof.	Installing a green roof without ensuring that the roof covering is water tight and that drainage systems function properly.
Including a moisture-monitoring system when installing a green roof to protect the historic building from added moisture and accidental leakage.	
Selecting sustainable native plants that are drought resistant and will not require excessive watering of a green roof.	
Selecting appropriately-scaled vegetation for a green roof that will not grow so tall that it will be visible and detract from the building's historic character.	Selecting vegetation for a green roof that will visible above the roof or parapet.

9. Site Features and Water Efficiency

Recommended	Not Recommended
Respecting an important cultural landscape and significant character-defining site features when considering adding new sustainable features to the site.	Installing new sustainable site features without considering their potentially negative impact on an important cultural landscape and character-defining site features.
Using to advantage existing storm-water-management features, such as gutters, downspouts and cisterns, as well as site topography and vegetation that contribute to the sustainability of the historic property.	Ignoring existing features that contribute to the sustainability of the historic property.

Adding natural, sustainable features to the site, such as shade trees, if appropriate, to reduce cooling loads for the historic building.	Removing existing natural features, such as shade trees, that contribute to the building's sustainability.
	Planting trees where they may grow to encroach upon or damage the historic building.
Using permeable paving where appropriate on a historic building site to manage storm water.	
Avoiding paving up to the building foundation to reduce heat island effect, building temperature, damage to the foundation and storm-water runoff.	Paving up to the building foundation with impermeable materials.
Landscaping with native plants, if appropriate, to enhance the sustainability of the historic site.	Introducing non-native plant species to the historic site that are not sustainable.
Adding features, such as bioswales, rain gardens, rain barrels, large collection tanks and cisterns, if compatible, to the historic building site to enhance storm water management & on-site water reuse.	

10. Day lighting

Recommended	Not Recommended
Retaining features that provide natural light to corridors, such as partial glass partitions, glazed doors and transoms, commonly found in historic office buildings.	Removing or covering features that provide natural light to corridors, such as partial glass partitions, glazed doors and transoms, commonly found in historic office buildings.
Reopening historic windows that have been blocked in to add natural light and ventilation.	Blocking in historic window openings to accommodate new building uses.
Adding skylights or dormers on secondary roof elevations where they are not visible or are only minimally visible so that they do not negatively impact the building's historic character.	Adding skylights or dormers on primary or highly- visible roof elevations where they will negatively impact the building's historic character.

Adding a small light well or light tubes, where necessary and appropriate, to allow more daylight into the historic building.	
Inserting a small atrium, only when necessary, to allow more daylight into the building in a manner that is compatible with the historic character of the building.	Cutting a very large atrium into the historic building that is not compatible with the building's historic character.
	Creating an open, uncovered atrium or courtyard in the historic building that appears to be an outdoor space, rather than an interior space.
Installing light-control devices on the historic building where appropriate to the building type, such as light shelves in industrial or mid-century modern buildings, awnings on some commercial and residential buildings and shutters on residential buildings that had them historically.	Installing light-control devices that are incompatible with the type or style of the historic building.
Installing automated day lighting controls on interior lighting systems that ensure adequate indoor lighting and allow for energy-saving use of day lighting.	
Adding new window openings on secondary and less visible facades, where appropriate, to allow more natural light into the historic building.	Adding new window openings on primary elevations that will negatively impact the character of the historic building.

As discussed in Chapter 4, preservationists insist that any alterations or new construction of a historic house should be able to be removed in the future if desired. This is sometimes referred to as the reversibility of the changes taking place. This requirement is mentioned throughout the guidelines.

Appendix C

Related Resources

There are several aspects that need to be taken into consideration when rehabilitating a historic home. Chapter 6 discusses many of the building and energy codes, guidelines, permits, and tax incentives that need to be obtained and/or can be used when retrofitting an attic in a historic house. The following is a list of resources that can be used to aid the owner of a historic house before, during, and after a retrofit:

- 20% Historic Rehabilitation Tax Credit
<http://www.nps.gov/tps/tax-incentives/before-you-apply.htm> &
<http://www.nps.gov/tps/tax-incentives/taxdocs/intro-wood-frame.pdf>
- Database of State Incentives for Renewables & Efficiency
<http://www.dsireusa.org/>
- Delaware County, Indiana Required Permits
<http://www.co.delaware.in.us/departments/division.php?fDD=5-295>
- DNR & DHPA Residential Historic Rehabilitation Credit
<http://www.in.gov/dnr/historic/3679.htm>

- Emily Kimbrough Historic District Preservation & Redevelopment Guidelines
http://www.muncie-ecna.org/Upload/EKNDC/EKNDC_Historic_Preservation_Guidelines_Vol_1.pdf
- Indiana Administrative Code
<http://www.in.gov/legislative/iac/>
- International Building Code 2012
<http://publicecodes.cyberregs.com/icod/ibc/2012/index.htm>
- International Residential Code 2012
http://publicecodes.cyberregs.com/icod/irc/2012/icod_irc_2012_8_sec006.htm
- International Energy Conservation Code 2012
<http://publicecodes.cyberregs.com/icod/iecc/2012/index.htm>
- Preservation Brief #3: Improving Energy Efficiency in Historic Buildings
<http://www.nps.gov/tps/how-to-preserve/briefs/3-improve-energy-efficiency.htm>
- Preservation Brief #4: Roofing For Historic Buildings
<http://www.nps.gov/tps/how-to-preserve/briefs/4-roofing.htm>
- Secretary of Interior Standards and Guidelines for Rehabilitation
<http://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf>
- Tax Incentives Assistance Project
http://www.energytaxincentives.org/consumers/insulation_etc.php

Glossary

Addition: Construction that increases the size of the original structure by building outside the existing walls or roof.

Air Barrier: Any part of a structure that restricts air flow.

Alteration: any physical changes to an existing structure or building including any construction, reconstruction, or removal of any building materials. This generally excludes maintenance work such as painting and repairs

Appropriate: Especially suitable or compatible.

Asphalt: A dark brown to black oil based material used as roof cladding.

Bay Window: Typically comprised of 3 to 5 windows on a protruding bay.

Batt: A blanket of insulation, usually fiberglass, made to fit between studs in a wall cavity.

Bitumen: The generic term for a semisolid mixture of complex chemicals derived from petroleum or coal after distillation. In roofing, there are two basic types including asphalt and coal-tar.

Blower Door: A tool used to measure air leakage rates. It consists of a fan, mounting panel, and a digital gauge to measure building pressures and flow.

Bracket: 1. An angled support that helps transfer the load of horizontal structural member to a vertical one. 2. Various decorative elements in the corner of an opening or below a projection.

Building Envelope: The shell of a building including exterior walls, roof, floors and foundation wall.

Bypass: Unintentional air leakage that can travel around the insulation of a building.

Ceiling Joist: A secondary horizontal framing member that supports the lath and plaster of a ceiling.

Certificate of Appropriateness (COA): Document stating that the proposed work on a historic structure is appropriate for the historic district that meets local building codes.

Character: A combination of form, proportion, structure, plan, style, or material that make up a distinctive nature of a building or neighborhood.

Cavity: An open area, partially or completely closed, within the framing of a structure, where insulation is to be installed.

Cladding: A covering or coating on a structure or material.

Compatible: In harmony with location and surroundings.

Conditioned: A space within a building envelope that is heated or cooled to the occupants desired temperature.

Conduction: When heat is transferred by direct contact of molecules/ surfaces.

Convection: The transfer of heat through movement of air, steam or water. When air is heated, it expands and becomes less dense and rises. When it cools, it compresses and sinks.

Cornice: 1. The projecting moldings forming the top band of an entablature, wall, or other element. 2: The projecting molding at the top of a door or window casing.

Crawl Space: The space under a house bounded by the foundation walls when a cellar is not present and the building does not sit on a concrete slab.

Cross-gable: A roof shape formed by the intersection of two gables, usually at the center of the roof.

Cut Nails: Nails made out of flat iron bar stock cut along alternating diagonals.

Design Guideline: Criteria developed to identify design concern in an area and to help property owners ensure that rehabilitation and new construction respect the character of designated buildings and districts.

Dormer: A projecting structure built out from a sloping roof, usually housing a window or vent.

Eave: The projection of a roof beyond the wall below; most often used to refer to the edge or underside of a roof.

Energy Efficiency: A ratio of energy output divided by the input.

Evaporation: The flow of heat as a material changes state from a liquid to a gas.

Façade: Any of the exterior faces of a building.

Felt Underlayment: An asphalt-saturated felt or other sheet material that is installed between the roof deck and the roofing material. It is primarily used to separate the roof covering from the roof deck, to shed water, and to provide secondary weather protection for the roof and the building below.

Fenestration: The arrangement of windows on a building façade.

Fiberglass: An insulating material made from spun glass.

Floor Joist: One of the horizontal framing members made of solid wood or laminated wood used to support the floor of a structure.

Foam Board: Foam insulation formed into panels.

Gable: The part of the wall that encloses the end of a pitched roof.

Gable Roof: A roof shape that is formed by two equal angled sloping planes rising from the side walls, meeting at a central ridge.

Gallery: A roofed promenade, especially one extending along the wall of a building and supported by posts on the outer side. In French Colonial architecture, the galleries can be on two sides or all sides surrounding the house.

Gambrel Roof: A gable roof with a double slope on each side with the lower slope having a steeper pitch.

Glazing: 1. Glass window. 2. Fitted or covered with glass.

Half-timbering: Having exposed wood framing with spaces filled with masonry or plaster.

Hardie board: Fiber cement siding made from Portland cement mixed with ground sand, cellulose fiber, and other additives. This siding can resemble stucco, wood clapboards, or cedar shingles. More durable than wood or stucco, is fire resistant, and requires little maintenance.

Heat Flow: The transfer of heat energy from hot to cold causing loss and gain of heat within a home.

Hipped Roof: A roof that slopes inward from all exterior walls, forms a pyramid roof above a square plans; has a ridge shorter than the length of the building above.

Historic Character: Visible and tangible assets of an old building that contribute to its architectural style and historical context

Historic District: A district is a geographically definable area, urban or rural, possessing a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united by past events or aesthetically by plan or physical development. A district may also comprise individual elements separated geographically but linked by association or history.

Historic Integrity: The authenticity of a property's historic identity—evidence given by the survival of physical characteristics that existed during the property's prehistoric or historic period. According to the National Park Service, historic integrity is composed of seven qualities: location, design, setting, materials, workmanship, feeling, and association. For the purposes of this thesis, the qualities of design, materials, workmanship, and feeling are of concern.

Historic Preservation Commission- Part of a local government, typically a city, given power through the state preservation enabling act, in which the government issues and regulates all aspects concerning the preservation of building and districts within a given jurisdiction.

Infill: 1. Undifferentiated material used for fill between other materials, such as random rubble in a stone wall.

In Kind: Made in a form or amount equivalent to another.

Insulation: A material used to reduce conductive thermal movement.

Integrity: See Historic Integrity.

Jetty: Any portion of a building that protrudes beyond the part immediately below it, just as a second story of a Garrison house.

Joist: A horizontal timber or steel supporting beam of the structure of a building the run parallel from wall to wall. It is used to support the ceiling or floor of a structure.

Knee Braces: A diagonal support placed across the angle between two members that are joined; serves to stiffen and strengthen the members.

Knee Wall: A short partition, usually under three feet in height, that is used to form a side wall under a pitched roof. Found in finished attics.

Latent Heat: When the addition or subtraction of heat results in moisture changes.

Mansard Roof: A roof having a double slope on all sides. The slope is typically either convex or concave.

Masonry: Stonework Including all stone products, all brick products and all concrete block units, decorative and customized blocks.

Mississippi Delta Cultural Hearth: An original source area with distinctive settlement forms as well as other cultural attributes. Mississippi Delta refers to an area around New Orleans settled by the French during their early exploration and has French and Cajun building traditions and characteristics.

Motif: A decorative design or pattern.

National Register of Historic Places: The National Register of Historic Places is the official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.

Ornamental: A feature serving or intended to be decorative, not structural.

Pane: One of the divisions of a window or door, consisting of a single unit of glass set in a frame.

Parapet: The part of a wall that projects above the adjacent roof; typically of solid construction but may also be crenellated or pierced.

Partition Wall: A wall that divides the interior of a structure.

Pier: 1. A square or rectangular masonry or wood post projecting less than a story above the ground that carries the weight of a structure down to the foundation, especially when larger or squatter than a column; may be a wood frame or part of a wall between a series of openings. 2: An isolated mass of masonry or concrete, or a cluster of piles, that supports a bridge or similar structure. 3. A masonry enclosure of a column to increase fire or water resistance.

Pitch: The degree of the slope of a roof; typically written in terms of how many inches in rise over 12 inches.

Preserve: The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property.

Pressure Boundary: The primary air barrier of a building.

Proportion- Harmonious relation of parts to one another or to the whole.

Purlin: A horizontal beam along the length of a roof, resting on a main rafter and supporting the common rafters or boards.

R value: A number designation of a material's ability to resist flow of heat. Higher numbers translate to higher resistance.

Radiation: Transfer of heat energy from one object to another through space. The sun is a source of radiant energy.

Rafters: A single board that helps make up a series of inclined members to which a roof covering is fixed; any of a series of small, parallel beams for supporting the sheathing and covering of a pitched roof.

Rehabilitation: The act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.

Resistance: Friction to the flow of energy that slows down the transference.

Restoration: The act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code- required work to make properties functional is appropriate within a restoration project.

Ridge Board: A horizontal board that serves as the peak of the roof structure.

Roof Decking: Also referred to as sheathing, usually of plywood or oriented-strand board (OSB) that is mounted onto the roof rafters and the roofing material is applied to.

Sensible Heat: Where the addition or subtraction of heat results in a temperature change.

Sensitive: Being conscious and undistruptive of the character or features of other architecture or neighborhoods.

Setback: The distance from which a house is located from the street.

Shingle: An exterior weather protection component for the roof or sidewall.

Siding: The nonstructural exterior wall covering of a wood frame building.

Sill: A strong horizontal member at the base of a structure and bears the upright portion of a frame.

Slope: A surface of which one end or side is at a higher level than another.

Soffit: The underside of an architectural structure such as an overhanging eaves.

Soffit Vent: A pre-manufactured air inlet source located at the lowest roof point, eave, or in the soffit of a roof assembly.

Spindle: A cylindrically symmetric shaft, usually made of wood, used as a decorative element.

Stack Effect: The movement of air into and out of buildings due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences.

Stucco: Type of fine plaster applied as a coating for wall surfaces or molding into architectural decorations.

Stud: Any of a number of slender, upright members of wood, steel, etc., forming the frame of a wall or partition and covered with plasterwork, siding, etc.

Thermal Boundary: A surface separated the heated part of a building from the outdoors or unconditioned parts, where the insulation is placed.

Thermal Bridging: A break in the layer of insulation caused by poor insulating materials allowing heat to transfer through the path with least thermal resistance. Ex: metal or wood rafters

Tie Beam: A horizontal beam connecting two rafters in a roof or roof truss.

Truss: A framework, typically consisting of a series of rafters and posts in a triangular shape supporting a roof.

Unconditioned Space: A zone within a building that is not intentionally heated or cooled.

Unsafe Building Ordinance: Regulation enabling a government to declare a building or structure unsafe and allows the said government to demolish structures deemed hazardous to the public.

Vapor Barrier: A material that prevents the passage of moisture.

Vernacular: A style of architecture exemplifying the most common building techniques based on the forms and materials of a particular historical period, region, or group of people.

Wall Dormer: A dormer whose face is flush with the face of the wall below, breaking the line at the cornice of the building.

Weatherization: The process of retrofitting a structure to decrease energy use, address health and safety concerns, increase durability, and increase comfort for occupants.

Weatherstrip: Gaskets used to reduce air infiltration.

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